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UNITED STATES DEPARTMENT OF AGRICULTURE
Bureau of Agricultural Chemistry and Engineering,
WASHINGTON, D. C

# REPORT OF STUDIES ON UNIFORMITY OF QUALITY OF SUGARS

## I. Chemical Studies on Beet Sugars of the 1941 Campaign

By C. A. Fort, S. Byall and R. M. Kingsbury

## II. Report on Biological Studies of Sugars

By H. H. Hall and Edna E. Dicks

Agricultural Chemical Research Division,
Bureau of Agricultural Chemistry and Engineering,
U. S. Department of Agriculture.

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# PART I

# CHEMICAL STUDIES ON BEET SUGARS OF THE 1941 CAMPAIGN

By C. A. Fort, S. Byall and R. M. Kingsbury

Campaign composites of the sugar produced at each of the 80 factories operating during the 1941 harvest were received and have been examined chemically, physically, and biologically. Twelve additional beet sugars were also included in the studies. The factory operating data which were submitted with the samples, and the chemical and physical test results obtained on the sugars, will be presented in this portion of the report. The biological studies made by H. H. Hall and Edna E. Dicks will be found in Part II. Composite white massecuite and molasses samples which were also supplied this year will be analyzed and reported at a later date.

As in the 1940 report, the data of all kinds is arranged in dual tables, the first part being for non-Steffen factories and the second part for the Steffen factories. Tables 1 to 4, inclusive, cover the operating data, tables 5 to 8, inclusive, the analytical studies of the sugars, table 10 summarizes the average data for the four major geographical groups of factories, and table 9 deals with the screening tests. Special attention was given to the measurement of the color and turbidity of the sugars and barley candies in solution, to reflectance measurements, to the foaming test, to nitrogen determinations, to estimations of total salts, to specific conductivity-ash factors, and to a more comprehensive formula for rating the sugars.

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## ACKNOWLEDGMENT

The cooperation of the various sugar companies and personnel in submitting the samples and factory data which made these investigations possible is greatly appreciated. The evident care used in preparing and shipping the samples and in filling out the information sheets is very commendable. As a result of this cooperation, there have been obtained data which should provide a basis for obtaining further improvements in the uniformity and quality of sugars.

## Table 1

## PROCESS DATA, NON-STEFFEN

| Sample | Beets | | Diffusion Juice | | | Liming Data | | | Soda | Carbonation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Sucrose | Purity | Draft % | Brix | Purity | Total % | Predef. | 2nd Carb | Ash lbs. | Alkalinities 1st | 2nd | pH 2nd Carb. |
| 4103 | 15.64 | -- | 156 | 11.3 | 87.8 | 1.40 | 0 | 0.04 | 0.13 | 0.076 | -- | 9.1 |
| 4105 | 15.71 | 85.2 | 152 | 11.9 | 86.1 | 2.34 | 0.2 | 0.2 | 0.009 | 0.078 | 0.017 | 8.8 |
| 4106 | 17.84 | 84.4 | 143 | 14.1 | 86.9 | 2.54 | 0 | 0.1 | 0 | 0.090 | 0.013 | -- |
| 4108 | 17.47 | 88.3 | 169 | 11.7 | 89.7 | 2.41 | 2.21 | 0.2 | 0 | 0.080 | 0.013 | 8.8 |
| 4110 | 16.05 | -- | 165 | 10.8 | 88.8 | 1.17 | 1.17 | 0 | 0.03 | 0.066 | -- | 9.2 |
| 4111 | 14.95 | -- | 145 | 11.9 | 86.0 | 1.32 | 1.32 | 0 | 0.41 | 0.079 | -- | 9.3 |
| 4112 | 16.87 | 86.8 | 165 | 11.5 | 88.6 | 1.95 | 1.95 | 0 | 0 | 0.065 | 0.015 | -- |
| 4114 | 16.61 | 85.2 | 128 | 14.7 | 87.7 | 2.37 | 0.47 | 0.1 | 0 | 0.075 | 0.014 | 8.7 |
| 4115 | 13.88 | 85.8 | 124 | 12.8 | 85.8 | 2.06 | 0.25 | 0.1 | 0.14 | 0.085 | 0.025 | 8.9 |
| 4116 | 16.92 | 83.1 | 144 | 13.8 | 86.5 | 2.39 | - | - | 0 | 0.067 | 0.016 | 8.8 |
| 4117 | 17.36 | 87.4 | 126 | 15.3 | 88.1 | 2.57 | 2.53 | 0.04 | 0.28 | 0.064 | 0.019 | 9.1 |
| 4118 | 15.80 | 86.1 | 148 | 11.9 | 88.1 | 2.68 | 2,68 | 0 | 0 | 0.102 | 0.020 | 9.1 |
| 4121 | 14.96 | 84.2 | 133 | 12.9 | 85.6 | 2.29 | 0.30 | 0 | 0 | 0.089 | 0.024 | 9.0 |
| 4122 | 15.20 | 86.6 | 162 | 10.7 | 86.6 | 1.33 | 0 | 0 | 0.11 | 0.075 | -- | 9.2 |
| 4123 | 14.90 | 81.4 | 166 | 9.5 | 83.6 | 2.45 | 0 | 0 | 0 | 0.102 | 0.022 | 8.6 |
| 4125 | 15.98 | -- | 164 | 10.9 | 88.4 | 1.10 | 0 | 0 | 0.10 | 0.074 | -- | 9.2 |
| 4132 | 15.26 | -- | 156 | 11.0 | 87.9 | 1.40 | 1.40 | 0 | 0.26 | 0.084 | -- | 9.4 |
| 4133 | 14.45 | 82.9 | 161 | 11.5 | 85.1 | 2.30 | 0 | 0 | 0.24 | 0.073 | 0.016 | -- |
| 4134 | 16.47 | 85.0 | 139 | 13.6 | 85.4 | 2.14 | 0 | 0 | 0.20 | 0.087 | -- | 8.3 |
| 4135 | 16.33 | 85.1 | 154 | 12.2 | 86.5 | 1.67 | 0.22 | 1.45 | 0 | 0.080 | -- | 9.0 |
| 4136 | 13.78 | 82.2 | 143 | -- | 84.7 | 2.75 | 2.50 | 0.25 | 0.05 | 0.095 | 0.018 | 8.7 |
| 4138 | 14.79 | 84.8 | 146 | 11.5 | 86.6 | 2.70 | 2.70 | 0 | 0 | 0.098 | 0.018 | 8.8 |
| 4139 | 16.02 | 86.1 | 143 | 12.7 | 86.9 | 1.88 | 0 | 0 | 0.12 | 0.080 | 0.021 | -- |
| 4143 | 17.29 | -- | 160 | 12.0 | 89.1 | 1.24 | 0 | 0 | 0.02 | 0.007 | -- | 9.3 |
| 4144 | 16.49 | -- | 157 | 11.9 | 87.5 | 1.49 | 1.39 | 0.10 | 0.01 | 0.076 | -- | 9.5 |
| 4145 | 16.93 | 83.3 | 139 | 13.3 | 87.0 | 2.45 | 0 | 0.11 | 0 | (11.3) | -- | 8.7 |
| 4147 | 14.24 | -- | 127 | 12.3 | 85.1 | 2.50 | 0 | 0 | 0 | 0.079 | 0.020 | -- |
| 4149 | 17.52 | 88.7 | 140 | 13.6 | 90.3 | 2.11 | 0 | 0.11 | 0 | 0.067 | 0.024 | 9.7 |
| 4150 | 15.88 | -- | 168 | 10.7 | 87.5 | 1.42 | 1.41 | 0.01 | 0.07 | 0.067 | -- | 9.3 |
| 4151 | 15.39 | 86.4 | 160 | 10.8 | 87.7 | 2.75 | 0 | 0 | 0.33 | 0.082 | 0.010 | -- |
| 4152 | 14.76 | 83.8 | 146 | 11.4 | 86.6 | 2.25 | 0 | 0.21 | 0 | 0.094 | -- | 9.2 |
| 4159 | 16.71 | 86.9 | 152 | 12.3 | 87.7 | 2.65 | 0 | 0 | 0 | 0.086 | -- | 9.1 |
| 4161 | 17.12 | 86.8 | 162 | 11.9 | 88.9 | 1.63 | 0 | 0 | 0.06 | 0.070 | 0.017 | -- |
| 4166 | 15.56 | 87.4 | 154 | 12.2 | 87.6 | 2.21 | 0 | 0.10 | 0.40 | 0.101 | 0.019 | 8.8 |
| 4167 | 17.34 | 87.9 | 170 | 11.5 | 90.2 | 2.47 | 0 | 0.23 | 0 | 0.078 | 0.015 | 8.9 |
| 4169 | 15.98 | 84.1 | 143 | 12.9 | 85.2 | 2.04 | 0 | 0.02 | 0.01 | 0.091 | 0.015 | 9.1 |
| 4173 | 14.16 | 83.9 | 134 | 12.1 | 85.4 | 1.89 | 0 | 0.20 | 0 | 0.088 | 0.025 | -- |
| 4176 | 16.26 | 87.2 | 144 | 12.4 | 89.3 | 2.52 | 0 | 0.01 | 0.49 | 0.077 | 0.014 | 9.0 |
| 4180 | 15.76 | 84.5 | 152 | 11.8 | 87.9 | 2.61 | 2.61 | 0 | 0 | 0.076 | 0.015 | 8.8 |
| 4182 | 15.64 | -- | 160 | 11.0 | 88.0 | 1.15 | 1.15 | 0 | 0.15 | 0.079 | -- | 8.4 |
| 4191 | 16.21 | -- | 134 | 13.5 | 87.7 | 2.39 | 2.14 | 0.25 | 0 | 0.099 | 0.033 | -- |
| 4194 | 18.49 | 86.8 | 154 | 13.3 | 89.1 | 2.20 | 0 | 0.10 | 0.08 | 0.077 | 0.011 | 8.5 |
| 4196 | 16.39 | -- | 134 | 13.6 | 86.5 | 2.69 | 2.44 | 0.25 | 0 | 0.102 | 0.033 | -- |
| Average | 15.91 | -- | 150 | 12.1 | 87.2 | 2.11 | -- | -- | 0.09 | 0.081 | 0.018 | -- |
| 1940 Avg. | 15.8 | -- | -- | -- | 86.8 | 2.08 | -- | -- | 0.14 | 0.081 | 0.019 | -- |

Samples 4191-4 & 6 not included in the averages

## Table 1

## PROCESS DATA, STEFFEN

| Sample Number | Beets |  | Diffusion Juice |  |  | Liming Data |  |  | Soda Ash | Carbonation Alkalinities |  | pH 2nd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Sucrose | Purity | Draft % | Brix | Purity | Total % | Bfr. Heat | 2nd Carb | lbs. | 1st | 2nd | Carb. |
| 4101 | 15.16 | 83.4 | 149 | 12.0 | 86.4 | 4.19 | 0 | 0.20 | 0.39 | 0.085 | 0.022 | 9.2 |
| 4102 | 17.26 | -- | 143 | 13.9 | 87.1 | 3.59 | 0 | 0 | 1.02 | .054 | -- | 8.9 |
| 4104 | 15.28 | 86.1 | 162 | 10.6 | 87.2 | 4.47 | 0 | 0 | 0.53 | .062 | .030 | 9.1 |
| 4107 | 16.52 | -- | 155 | 11.8 | 89.1 | 2.70 | - | - | 0 | .063 | -- | 9.1 |
| 4109 | 14.90 | 82.2 | 152 | 11.3 | 85.0 | 4.74 | 0 | 0.25 | 1.03 | .086 | .017 | 8.5 |
| 4113 | 15.40 | 86.5 | 129 | 13.3 | 88.3 | 3.61 | 0.31 | 0.25 | 0.74 | .088 | .022 | 8.9 |
| 4119 | 15.21 | 82.8 | 158 | 11.3 | 84.0 | 4.96 | 0 | 0 | 0.23 | .052 | .021 | 9.0 |
| 4120 | 16.78 | 88.5 | 146 | 12.6 | 89.8 | 3.14 | 0 | 0.01 | 0.01 | .078 | -- | 9.1 |
| 4124 | 15.36 | 87.0 | 163 | 10.7 | 87.0 | 2.81 | - | - | 0.19 | .073 | -- | 9.1 |
| 4126 | 14.85 | -- | 153 | 11.0 | 86.0 | 2.39 | 0 | 0 | 0.72 | .061 | -- | 9.2 |
| 4127 | 15.83 | 84.2 | 154 | 11.8 | 85.7 | 4.16 | 0 | 0.24 | 0.86 | .087 | .022 | 8.8 |
| 4128 | 12.54 | 76.3 | 150 | 10.6 | 77.7 | 4.6 | 0 | 0 | 0.33 | .060 | -- | 8.1 |
| 4129 | 16.38 | 85.6 | 145 | 12.8 | 87.0 | -- | 0 | 0.08 | 0.24 | .070 | .015 | 9.0 |
| 4130 | 15.61 | -- | 159 | 11.2 | 86.8 | 2.41 | 2.41 | 0 | 0.28 | .065 | -- | 9.1 |
| 4131 | 13.48 | 82.8 | 135 | 11.6 | 83.4 | 4.15 | 0 | 0 | 0.54 | .093 | .020 | 8.9 |
| 4137 | 17.18 | 87.7 | 136 | 13.9 | 89.6 | 4.26 | 3.35 | 0.41 | 0.37 | .075 | .017 | 9.2 |
| 4140 | 15.95 | 85.3 | 154 | 11.8 | 86.8 | 2.92 | 0 | 0 | 0.39 | .061 | .015 | -- |
| 4141 | 15.69 | -- | 159 | 11.1 | 87.9 | 2.39 | 0 | 0 | 0.23 | .065 | -- | 9.2 |
| 4142 | 15.76 | -- | 162 | 10.9 | 88.1 | 2.33 | 0 | 0 | 0.16 | .079 | -- | 9.1 |
| 4146 | 13.44 | -- | 144 | 10.7 | 85.4 | 3.72 | - | - | 0.30 | .077 | .011 | 8.4 |
| 4153 | 16.52 | 86.1 | 171 | 10.9 | 88.1 | 3.75 | 0 | 0 | 0.37 | .067 | .015 | 9.1 |
| 4155 | 14.01 | 81.0 | 147 | 11.4 | 81.4 | 3.82 | 0.30 | 0 | 1.67 | .069 | .019 | -- |
| 4156 | 14.84 | -- | 163 | 10.6 | 85.3 | 2.24 | 0 | 0 | 1.14 | .070 | -- | 9.3 |
| 4157 | 17.09 | 85.2 | 141 | 13.8 | 86.5 | 5.93 | 0 | 0 | 2.75 | .079 | .013 | 9.1 |
| 4158 | 14.39 | 82.6 | 150 | 11.2 | 83.8 | 4.70 | 4.50 | 0.20 | 0 | .052 | .022 | -- |
| 4160 | 14.61 | 86.3 | 144 | 11.3 | 87.8 | 3.99 | 0 | 0 | 0 | .073 | .014 | 9.2 |
| 4162 | 14.65 | 85.4 | 147 | 10.9 | 87.6 | 4.61 | - | - | 0.44 | .083 | .016 | 8.8 |
| 4163 | 15.11 | 80.7 | 158 | 10.9 | 86.0 | 4.88 | 0 | 0.30 | 1.84 | .093 | .020 | 9.1 |
| 4164(a) | 19.30 | -- | 142 | 15.6 | 85.9 | 3.57 | 0 | 0 | 1.43 | .074 | -- | 9.0 |
| 4164(b) | 14.27 | 77.1 | 136 | 13.6 | 77.8 | 6.10 | 0 | 0 | 1.96 | .087 | -- | 9.1 |
| 4165 | 15.84 | -- | 153 | 11.7 | 87.9 | 2.59 | 0 | 0 | 0.31 | .068 | -- | 9.1 |
| 4168 | 16.36 | 86.9 | 139 | 13.2 | 88.2 | 3.96 | 0 | 0 | 0 | (11.0) | -- | 8.7 |
| 4171 | 17.42 | 87.2 | 132 | 14.7 | 88.2 | 3.38 | 0 | 0 | 0.21 | (10.9) | -- | 9.2 |
| 4172 | 15.06 | -- | 163 | 10.5 | 86.9 | -- | - | - | 0.48 | .066 | -- | 9.2 |
| 4175 | 15.19 | 84.6 | 154 | 11.4 | 84.2 | 4.08 | - | 0.03 | 0 | .073 | -- | 8.9 |
| 4177 | 16.41 | 86.4 | 149 | 12.4 | 87.3 | 3.78 | 0 | 0 | 0.41 | .079 | .011 | 9.1 |
| 4178 | 15.50 | 84.3 | 140 | 12.9 | 84.1 | 4.21 | 4.21 | 0 | 1.07 | (11.2) | -- | 8.8 |
| 4179 | 17.00 | 87.4 | 148 | 12.6 | 89.6 | 3.14 | 0 | 0 | 0.13 | .078 | .014 | -- |
| 4183 | 16.55 | 86.0 | 143 | 12.5 | 87.7 | 4.21 | 0 | 0.08 | 0.06 | ( 9.9) | -- | 7.8 |
| 4184 | 15.76 | 86.6 | 132 | 13.4 | 88.0 | 3.42 | 0 | 0 | 0 | .080 | -- | 9.2 |
| 4195 | 18.12 | -- | 133 | 15.2 | 88.2 | 3.19 | - | 0.03 | 0.24 | .081 | .011 | 8.4 |
| Average | 15.61 | -- | 149 | 12.0 | 86.3 | 3.79 | - | - | 0.57 | .073 | .017 | -- |
| Avg.1940 | 15.8 | -- | -- | -- | 86.4 | 3.76 | - | - | 0.66 | .074 | .015 | -- |

Table 2

PROCESS DATA, NON-STEFFEN

| Sample Number | Thin Juice Sulphur lbs. | Thin Juice pH | Thick Juice Purity | Thick Juice pH | Standard Liquor or Blow-up Brix | Standard Liquor or Blow-up Filt. Aid lbs. | Standard Liquor or Blow-up Temp. Filt. | Standard Liquor or Blow-up Lime Salts | White Massecuite Brix | White Massecuite Purity | White Massecuite pH | White Massecuite Cu.Ft. per 100 sug. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4103 | 0.66 | 7.8 | -- | 8.4 | 69.6 | 0.20 | 89°C | 0.019 | 90.4 | 92.0 | 8.6 | 3.1 |
| 4105 | 0.62 | 8.4 | 90.0 | 9.2 | 70.6 | 0.45 | 96 | 0.022 | 91.7 | 92.7 | 9.1 | 2.75 |
| 4106 | 0.26 | -- | 91.3 | 8.9 | 64.1 | 0.67 | 92 | 0.027 | 91.3 | 93.5 | 8.9 | 2.66 |
| 4108 | 0.37 | 8.1 | 91.5 | 9.0 | 68.9 | 0.70 | 97 | 0.019 | 91.7 | 92.5 | 8.9 | 3.1 |
| 4110 | 0.41 | 8.0 | -- | 8.8 | 70.1 | 0.24 | 88 | 0.011 | 91.2 | 91.9 | 8.8 | 3.05 |
| 4111 | 0.60 | 8.2 | 89.6 | 8.8 | 67.5 | 0.19 | 90 | 0.039 | 91.8 | 90.6 | 8.6 | 2.60 |
| 4112 | 0.39 | 8.0 | 91.6 | 7.6 | 70.7 | 0.40 | 91 | -- | 91.2 | 91.9 | 7.4 | 2.7 |
| 4114 | 0.14 | 8.5 | 91.6 | 9.3 | 69.2 | 0.47 | 92 | 0.045 | 91.6 | 93.6 | 9.2 | 3.12 |
| 4115 | 0.51 | 8.5 | 90.2 | 7.9 | 65.9 | 0.66 | 82 | 0.076 | 90.1 | 93.0 | 7.3 | 3.20 |
| 4116 | 0.48 | 8.2 | 90.5 | 8.9 | 71.3 | 0.43 | 91 | 0.029 | 91.2 | 92.2 | 8.8 | 2.69 |
| 4117 | 0.37 | 8.6 | 92.7 | 8.6 | 66.4 | 0.70 | 88 | 0.041 | 92.2 | 94.4 | 8.4 | 2.96 |
| 4118 | *0.12 | 9.0 | 91.2 | 8.7 | 64.5 | 0.43 | 91 | 0.046 | 92.3 | 92.0 | 8.0 | 2.67 |
| 4121 | 0.58 | 8.1 | 90.2 | 8.2 | 67.9 | 0.60 | 96 | 0.031 | 91.3 | 92.1 | 7.8 | 3.02 |
| 4122 | 0.44 | 8.3 | -- | -- | 70.7 | 0.25 | 90 | 0.019 | 91.6 | 91.1 | 8.4 | 3.37 |
| 4123 | *0.16 | 8.6 | 89.3 | 8.6 | 70.4 | 0.60 | 96 | 0.028 | 91.2 | 91.3 | 8.6 | 2.89 |
| 4125 | 0.54 | 8.1 | 88.4 | 8.8 | 71.1 | 0.27 | 90 | 0.018 | 91.0 | 91.4 | 8.6 | 3.05 |
| 4132 | 0.46 | 8.1 | -- | 8.4 | 68.2 | -- | 93 | 0.018 | 91.9 | 91.9 | 8.4 | 3.02 |
| 4133 | 0.39 | 7.9 | 92.0 | 7.9 | 61.1 | 0.40 | 92 | 0.056 | 92.4 | 87.6 | 7.6 | 3.2 |
| 4134 | 0.22 | 8.5 | -- | 9.1 | 60.2 | 0.70 | 96 | 0.038 | 91.2 | 94.1 | 9.2 | 2.98 |
| 4135 | 0.48 | 7.8 | 90.4 | 9.0 | 69.1 | 0.29 | 89 | 0.024 | 92.2 | 93.1 | 9.1 | 2.68 |
| 4136 | * 0 | 8.7 | 90.2 | 9.3 | 63.6 | 0.60 | 90 | 0.020 | 90.0 | 92.6 | 8.4 | -- |
| 4138 | * 0 | 8.9 | 91.2 | 8.9 | 64.1 | 0.40 | 95 | 0.053 | 92.4 | 91.5 | 8.1 | 2.95 |
| 4139 | 0.39 | 7.6 | 89.6 | 8.5 | 67.4 | 0.57 | 90 | 0.037 | 92.1 | 91.0 | 8.4 | 2.79 |
| 4143 | 0.53 | 8.1 | -- | 9.1 | 69.7 | 0.16 | 89 | -- | 91.0 | 92.5 | 8.9 | 2.98 |
| 4144 | 0.57 | 8.0 | 90.8 | 8.7 | 67.1 | 0.45 | 93 | 0.020 | 91.6 | 92.0 | 8.5 | 2.64 |
| 4145 | 0.19 | 8.6 | 92.5 | 9.0 | 66.7 | 0.35 | 88 | 0.033 | 91.8 | 93.7 | 8.9 | 2.24 |
| 4147 | 0.13 | 8.5 | 91.6 | 8.6 | 61.8 | 0.44 | 95 | 0.024 | 89.3 | 92.2 | 8.4 | 2.69 |
| 4149 | 0.69 | 7.3 | 93.1 | 7.9 | 70.5 | 0.65 | 96 | 0.012 | 91.3 | 94.1 | 7.6 | 2.74 |
| 4150 | 0.47 | 8.1 | -- | 8.6 | 67.9 | 0.29 | 86 | 0.019 | 90.2 | 91.8 | 8.6 | 3.01 |
| 4151 | * 0 | -- | -- | -- | 55.8 | 0.50 | 95 | 0.125 | 89.8 | 90.9 | -- | -- |
| 4152 | * 0 | 9.2 | 92.5 | 9.2 | 57.5 | 0.50 | 95 | -- | 92.2 | 90.1 | 7.9 | -- |
| 4159 | 0.84 | 7.6 | 92.8 | 8.2 | 68.8 | 0.53 | 97 | 0.023 | 91.2 | 92.3 | 7.9 | 2.99 |
| 4161 | 0.51 | 7.9 | 90.0 | 7.5 | 64.6 | 0.51 | 93 | -- | 91.9 | 90.7 | 7.3 | 2.77 |
| 4166 | *0.10 | 8.8 | 91.2 | 8.7 | 67.3 | 0.30 | 94 | 0.048 | 91.1 | 92.6 | 7.9 | 2.88 |
| 4167 | 0.35 | 8.0 | -- | 9.0 | 69.0 | 0.46 | 94 | 0.032 | 91.6 | 93.4 | 9.0 | 2.52 |
| 4169 | 0.57 | 7.7 | 90.8 | 8.2 | 71.6 | 0.38 | 95 | 0.025 | 91.4 | 91.7 | 8.5 | 3.03 |
| 4173 | *0.17 | 8.7 | 89.7 | 9.4 | 66.7 | 0.38 | 92 | 0.051 | 92.2 | 91.2 | 7.4 | 3.41 |
| 4176 | 0.19 | 8.5 | 92.5 | 8.4 | 71.1 | 0.50 | 94 | 0.042 | 92.4 | 94.3 | 8.4 | 2.9 |
| 4180 | 0.40 | 7.9 | 89.7 | 8.8 | 68.6 | 0.36 | 94 | 0.029 | 92.4 | 91.4 | 8.8 | 2.58 |
| 4182 | 0.37 | 8.4 | -- | 8.6 | 69.9 | 0.29 | 89 | -- | 91.0 | 91.9 | 8.6 | 2.8 |
| 4191 | *0.22 | 8.7 | 92.2 | 8.7 | 64.4 | 0 | 94 | 0.020 | 91.9 | 90.3 | 8.3 | 2.58 |
| 4194 | 0.34 | 8.2 | 91.3 | 8.3 | 66.7 | 0.34 | 89 | 0.048 | 92.2 | 92.5 | 9.2 | 2.81 |
| 4196 | *0.26 | -- | 90.5 | -- | 65.4 | 0.10 | 93 | 0.026 | 92.2 | 89.2 | 8.1 | 2.76 |
| Average | 0.43 | tot.8.24 | 91.0 | 8.65 | 67.1 | 0.44 | -- | 0.034 | 91.4 | 92.1 | 8.39 | 2.71 |
| Avg.1940 | 0.46 | 8.16 | -- | 8.59 | 67.4 | 0.44 | -- | 0.032 | -- | 91.8 | -- | -- |

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* Additional sulphur used on thick juice, 4118-0.13, 4123-0.16, 4136-0.34, 4138-0.18, 4151-0.45, 4152-0.53, 4166-0.14, 4173-0.40, 4191-0.10, 4196-0.19.

Table 2

PROCESS DATA, STEFFEN

| Sample Number | Thin Juice Sulphur lbs. | Thin Juice pH | Thick Juice Purity | Thick Juice pH | Standard Liquor or Blowup Brix | Filt.Aid lbs. | Temp. Filt. | Lime Salts | White Massecuite Brix | Purity | pH | Cu.Ft. per 100 sug. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4101 | *0.30 | 9.1 | 91.5 | 8.7 | 64.8 | 0.59 | 100°C | 0.059 | 90.9 | 93.1 | 8.2 | 3.39 |
| 4102 | 0.33 | 9.3 | 90.4 | 9.1 | 70.4 | 0.51 | 70 | .045 | 92.0 | 94.7 | 8.9 | 2.90 |
| 4104 | * 0 | 9.1 | - | - | 62.2 | 0.70 | 94 | .026 | 91.6 | 91.1 | 8.3 | 2.59 |
| 4107 | *0.32 | 7.8 | 92.7 | 8.5 | 70.5 | 0.48 | 93 | -- | 90.5 | 93.5 | 8.4 | 3.3 |
| 4109 | 0.20 | 8.2 | 90.4 | 8.2 | 69.3 | 0.69 | 93 | .049 | 90.6 | 92.2 | 8.2 | 3.45 |
| 4113 | *0.07 | 8.6 | 91.4 | 8.6 | 62.1 | 0.82 | 95 | .061 | 91.2 | 92.4 | 7.5 | 3.49 |
| 4119 | * 0 | 9.0 | 90.6 | 8.6 | 67.0 | 0.72 | 95 | .072 | 90.6 | 91.4 | 7.6 | 3.02 |
| 4120 | *0.22 | 8.6 | 92.4 | 8.7 | 71.8 | 0.23 | 83 | .032 | 90.9 | 93.2 | 8.0 | 3.18 |
| 4124 | 0.50 | 7.9 | -- | 8.0 | 70.3 | 0.58 | 94 | .041 | 91.9 | 92.0 | 7.9 | 2.84 |
| 4126 | 0.47 | 8.2 | 90.7 | 8.2 | 69.2 | 0.60 | 90 | -- | 90.3 | 90.8 | 8.2 | 3.5 |
| 4127 | 0.30 | 8.5 | 90.5 | 8.7 | 67.9 | 0.62 | 97 | .064 | 90.3 | 92.1 | 8.7 | 2.67 |
| 4128 | * 0 | 8.0 | 86.2 | 9.4 | 64.7 | 0.44 | 93 | .096 | 92.2 | 88.1 | 8.2 | 3.3 |
| 4129 | 0.37 | 8.4 | 91.6 | 8.5 | 66.0 | 0.62 | 95 | .044 | 91.6 | 92.4 | 8.5 | -- |
| 4130 | 0.59 | 8.2 | 90.8 | 8.8 | 72.7 | 0.34 | 87 | -- | 90.3 | 91.2 | 8.9 | 3.12 |
| 4131 | 0.57 | 8.0 | 90.1 | 7.8 | 66.6 | 0.43 | -- | .036 | 90.2 | 92.6 | 7.6 | 3.03 |
| 4137 | 0.33 | 8.2 | 93.1 | 8.2 | 68.6 | 0.45 | 91 | .056 | 91.3 | 93.7 | 7.9 | 2.38 |
| 4140 | 0.37 | 8.0 | 91.4 | 8.0 | 68.0 | 0.86 | 84 | .054 | 91.4 | 90.6 | 8.0 | 3.35 |
| 4141 | 0.37 | 8.0 | 91.0 | 8.0 | 70.0 | 0.41 | 95 | .043 | 90.5 | 92.8 | 7.9 | 3.16 |
| 4142 | 0.32 | 8.1 | -- | 8.5 | 70.3 | 0.42 | -- | -- | 90.6 | 92.5 | 8.5 | 2.96 |
| 4146 | *0.30 | 7.5 | 90.2 | 7.4 | 69.5 | 0.44 | -- | .068 | 90.8 | 92.3 | 7.4 | -- |
| 4153 | 0.26 | 8.2 | 93.1 | 8.0 | 68.1 | 0.79 | 88 | -- | 92.1 | 94.2 | 8.2 | 2.92 |
| 4155 | 0.35 | 8.3 | 87.3 | 8.4 | 69.1 | 0.50 | 92 | .115 | 91.3 | 89.4 | 8.0 | 2.97 |
| 4156 | 0.62 | 8.2 | -- | 8.6 | 67.3 | 0.86 | 91 | -- | 91.6 | 91.2 | 8.6 | 3.17 |
| 4157 | 0.45 | 8.3 | 90.6 | 7.6 | 68.2 | 0.51 | 95 | .049 | 90.8 | 93.2 | 7.5 | 3.14 |
| 4158 | * 0 | -- | 91.0 | -- | 60.7 | 0.50 | 95 | .130 | 91.0 | 92.0 | 7.8 | -- |
| 4160 | 0.48 | 7.9 | 92.7 | 8.2 | 71.4 | 0.55 | 90 | .032 | 91.4 | 94.4 | 8.2 | 3.86 |
| 4162 | *0.07 | 8.9 | 91.6 | 8.7 | 62.0 | 0.98 | 94 | .043 | 90.7 | 92.7 | 7.7 | 2.97 |
| 4163 | * 0 | 9.1 | 91.5 | 8.8 | 65.1 | 0.89 | 98 | .056 | 91.7 | 92.3 | 8.5 | 3.12 |
| 4164(a) | 0.37 | 8.4 | 89.4 | 7.4 | 66.0 | 0.92 | 97 | .084 | 91.1 | 93.0 | 7.3 | 2.75 |
| 4164(b) | 0.33 | 8.7 | 84.1 | 7.7 | 65.4 | 0.62 | 97 | .039 | 89.6 | 97.4 | 6.6 | 3.05 |
| 4165 | 0.40 | 7.9 | -- | -- | 71.4 | 0.45 | 90 | -- | 89.5 | 92.0 | -- | 2.83 |
| 4168 | *0.30 | 8.3 | -- | -- | 62.6 | 0.40 | 89 | .046 | 90.8 | 92.0 | 8.8 | 3.10 |
| 4171 | 0.19 | 8.6 | 92.5 | 8.1 | 67.9 | 0.46 | 95 | .098 | 90.7 | 94.2 | 8.0 | 3.10 |
| 4172 | 0.51 | 8.4 | -- | 8.2 | 68.5 | 0.58 | 93 | -- | 91.8 | 90.7 | 8.3 | 2.97 |
| 4175 | *0.01 | 8.7 | 91.0 | 8.8 | 64.7 | 0.44 | 100 | .053 | 90.8 | 92.9 | 8.5 | 2.90 |
| 4177 | 0.26 | 8.4 | 91.3 | 8.8 | 69.8 | 0.26 | 94 | .034 | 90.3 | 92.9 | 8.8 | 2.73 |
| 4178 | 0.22 | 8.9 | 89.3 | 8.8 | 70.6 | 0.64 | 99 | .058 | 92.1 | 92.5 | 8.6 | 2.83 |
| 4179 | 0.32 | 8.1 | 91.3 | 7.3 | 61.0 | 0.80 | 91 | -- | 90.4 | 91.6 | 7.2 | 3.20 |
| 4183 | 0.40 | (7.3) | 91.2 | (7.8) | 61.5 | 0.50 | 92 | -- | 92.6 | 93.9 | 7.8 | 2.70 |
| 4184 | *0.10 | 9.0 | -- | 9.2 | 67.0 | 0.36 | 96 | .026 | 91.5 | 92.9 | 8.1 | 2.91 |
| 4195 | *0.50 | 7.8 | 90.4 | 7.6 | 65.1 | 0.53 | 95 | .071 | 90.9 | 89.3 | 7.1 | 3.08 |
| Average | 0.37 tot. | 8.39 | 90.7 | 8.37 | 67.3 | 0.57 | -- | 0.059 | 91.0 | 92.4 | 8.06 | 3.05 |
| Avg.1940 | 0.38 | 8.24 | -- | 8.26 | 66.3 | 0.58 | -- | 0.055 | -- | 92.2 | -- | -- |

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* Additional sulphur used on thick juice, 4101-0.11,4104-0.13,4107-0.05,4113-0.17, 4119-0.18,4120-0.10,4128-0.46,4146-0.21,4158-0.44,4162-0.27,4163-0.09,4168-0.28, 4175-0.37,4184-0.39,4195-0.03.

Table 3

PROCESS DATA, NON-STEFFEN

| Sample | Water on Wht.Sugar | | White Sugar | | High Green | | High Wash | | High Raw Massecuite | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | per mach. qts. | per 100 sug.qts. | as Sacked Temp. | Moist. | Brix | Pur. | Brix | Pur. | Brix | Pur. | Cu.Ft.per100 Wht. | Raw sug. |
| 4103 | 18 | 4.8 | 39°C | 0.024 | 77.7 | 85.1 | 75.2 | 91.1 | 92.5 | 82.7 | -- | -- |
| 4105 | 17 | 6.0 | 39 | .034 | 69.0 | 87.7 | -- | 92.3 | 93.9 | 84.5 | -- | 2.57 |
| 4106 | 8 (130°C) | 2.0 | 36 | .022 | 80.0 | 87.9 | -- | 92.0 | 93.9 | 87.5 | -- | -- |
| 4108 | 18.2 | 7.2 | 42 | .033 | 69.8 | 86.7 | 79.9 | 91.1 | 92.6 | 85.9 | -- | 2.64 |
| 4110 | 17 | 6.5 | 32 | .015 | 74.6 | 84.4 | -- | 89.8 | 93.8 | 81.4 | 1.46 | -- |
| 4111 | 15 | 7.0 | 33 | .013 | 70.2 | 82.5 | -- | 90.9 | 94.8 | 82.4 | 1.27 | -- |
| 4112 | 15 | 5.0 | 68 | .029 | 74.2 | 85.5 | -- | 88.8 | 93.6 | 85.5 | 0.94 | -- |
| 4114 | 21 | 8.0 | 44 | .029 | 72.3 | 87.8 | 62.0 | 93.2 | 93.5 | 84.9 | -- | 3.29 |
| 4115 | 22 | 7.8 | 48 | .040 | 72.5 | 87.2 | 78.0 | 94.3 | 90.9 | 87.4 | 1.57 | 2.15 |
| 4116 | 13 | 2.9 | 46 | .038 | 70.6 | 85.4 | 71.0 | 90.5 | 93.8 | 83.4 | 1.58 | 2.56 |
| 4117 | 18 | 6.0 | 49 | .019 | 78.2 | 88.5 | 74.9 | 95.0 | 93.1 | 88.4 | 1.36 | 2.58 |
| 4118 | 13.5 | 8.0 | 43 | .022 | 71.9 | 83.4 | 71.4 | 91.5 | 93.8 | 83.4 | -- | -- |
| 4121 | 18.4 | 5.4 | 50 | .035 | 75.7 | 85.8 | 77.4 | 93.3 | 91.8 | 86.2 | -- | 2.81 |
| 4122 | 16 | 6.7 | 41 | .024 | 74.4 | 82.9 | -- | 90.6 | 93.4 | 82.1 | -- | -- |
| 4123 | 14 | 6.0 | -- | .026 | 80.5 | 85.1 | -- | 92.1 | 92.6 | 85.2 | 1.46 | -- |
| 4125 | 17 | 7.4 | 40 | .020 | 76.2 | 83.1 | 72.3 | 90.0 | 92.9 | 82.1 | 0.87 | -- |
| 4132 | 17 | 2.6 | 34 | .016 | 72.5 | 84.5 | -- | 93.2 | 93.4 | 84.5 | 1.40 | -- |
| 4133 | 21 | 7.0 | 58 | .03 | 60.0 | 76.0 | 65.0 | 85.0 | -- | -- | -- | -- |
| 4134 | 16.2 | 6.8 | -- | .023 | -- | 89.7 | -- | 94.6 | 92.9 | 89.0 | -- | 2.98 |
| 4135 | 15 | 4.6 | 55 | .027 | -- | 86.2 | -- | 91.0 | 93.9 | 86.1 | 2.18 | -- |
| 4136 | 16 | 8.0 | 62 | .042 | -- | 86.9 | -- | 91.5 | 91.4 | 86.3 | -- | 3.41 |
| 4138 | 14.5 | 5.8 | 47 | .033 | 63.5 | 83.7 | 65.2 | 89.3 | 92.6 | 83.3 | -- | 4.1 |
| 4139 | 17 | 4.3 | 52 | .026 | 66.3 | 84.1 | 66.3 | 89.3 | 94.0 | 84.4 | 1.92 | -- |
| 4143 | 17 | 4.9 | 45 | .024 | 75.6 | 86.7 | -- | 90.1 | 94.2 | 85.1 | 1.97 | -- |
| 4144 | 15 | 4.6 | 44 | .019 | 76.3 | 82.9 | 70.1 | 90.5 | 94.2 | 82.1 | 1.31 | 5.00 |
| 4145 | 14 | 5.9 | 52 | .020 | -- | 88.0 | -- | 92.8 | 92.6 | 87.0 | 1.91 | -- |
| 4147 | 16 | -- | 60 | .018 | -- | 86.5 | -- | 90.3 | 88.9 | 86.0 | -- | -- |
| 4149 | 18 | 6.0 | 56 | .029 | 78.5 | 88.1 | 72.0 | 93.3 | 90.6 | 86.5 | 1.31 | 3.08 |
| 4150 | 17 | 5.7 | 40 | .019 | 76.3 | 85.1 | 72.2 | 90.8 | 91.1 | 83.3 | -- | 3.01 |
| 4151 | 12 | -- | 65 | .028 | -- | 85.0 | -- | 91.1 | 90.8 | 83.5 | -- | -- |
| 4152 | 16 | 3.0 | 60 | .015 | -- | 80.8 | -- | 88.8 | -- | -- | -- | -- |
| 4159 | 14.5 | 4.3 | 53 | .039 | -- | 84.5 | -- | 91.6 | 93.2 | 84.3 | -- | -- |
| 4161 | 15 | 5.0 | -- | .023 | 71.5 | 84.0 | 73.2 | 91.2 | 92.7 | 83.8 | 0.87 | -- |
| 4166 | 14(125°C) | 4.0 | 49 | .028 | 72.5 | 85.3 | 76.8 | 91.6 | 91.3 | 83.3 | -- | 3.14 |
| 4167 | 18 | 6.0 | 50 | .022 | 68.0 | 87.3 | -- | 92.3 | 93.4 | 84.2 | 1.18 | -- |
| 4169 | 16 | 5.2 | 52 | .031 | 75.0 | 85.3 | 73.5 | 92.1 | 92.0 | 84.7 | 1.49 | -- |
| 4173 | 18.5 | 7.4 | 38 | .036 | 80.4 | 84.6 | 79.9 | 89.8 | 94.2 | 84.1 | 1.49 | -- |
| 4176 | 16.9 | 5.8 | 45 | .028 | 70.2 | 88.2 | -- | 94.1 | 93.9 | 85.0 | 1.64 | 2.54 |
| 4180 | 18 | 5.0 | 48 | .027 | 72.4 | 84.4 | -- | 89.9 | 94.6 | 84.9 | 1.31 | -- |
| 4182 | 16 | 6.4 | 39 | .020 | 73.8 | 84.2 | -- | 90.7 | 93.4 | 82.2 | -- | -- |
| 4191 | 16.8 | 5.2 | 52 | .042 | 68.1 | 78.3 | 70.1 | 82.4 | -- | -- | -- | -- |
| 4194 | 17 | 5.4 | 44 | .023 | 83.4 | 84.4 | 79.7 | 94.7 | 86.6 | 84.5 | 0.97 | -- |
| 4196 | 10.7 | 4.0 | 48 | .042 | 64.5 | 77.4 | 70.1 | 80.8 | -- | -- | -- | -- |
| Average | 16.2 | 5.7 | -- | .026 | 73.1 | 85.3 | -- | 91.3 | 92.9 | 84.7 | 1.43 | 3.06 |
| Avg.1940 | 16.0 | 5.4 | -- | .028 | -- | 84.8 | -- | 91.2 | 93.1 | 84.2 | -- | -- |

## Table 3

## PROCESS DATA, STEFFENS

| Sample | Water on Wht. Sugar | | White Sugar as sacked | | High Green | | High Wash | | High Raw Massecuite | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | per mach. qts. | per 100 sug. qts. | Temp. | Moist. | Brix | Pur. | Brix | Pur. | Brix | Pur. | Cu.Ft. per 100 | |
| | | | | | | | | | | | Wht. | Raw sug. |
| 4101 | 14 | 4.7 | 42°C | 0.028 | 61.3 | 86.6 | 60.6 | 91.1 | 90.1 | 86.6 | 1.14 | -- |
| 4102 | 16 | 5.0 | 45 | .017 | 82.1 | 88.7 | -- | 94.6 | 93.7 | 87.7 | 2.31 | -- |
| 4104 | 10.5 | 3.0 | 54 | .032 | 61.5 | 82.0 | 60.2 | 88.8 | -- | -- | -- | -- |
| 4107 | 17 | 6.9 | 44 | .026 | 78.4 | 88.0 | 76.4 | 91.6 | 91.9 | 86.4 | -- | 2.50 |
| 4109 | 14 | 6.0 | 47 | .053 | -- | 86.3 | -- | 90.3 | 89.4 | 86.5 | -- | 3.24 |
| 4113 | 22 | 7.0 | 52 | .030 | 84.0 | 85.4 | 72.0 | 90.5 | 87.2 | 84.1 | 0.85 | -- |
| 4119 | 13.5 | 5.2 | 47 | .033 | -- | 84.1 | -- | 89.1 | 91.3 | 85.0 | -- | 2.78 |
| 4120 | 18 | 9.0 | 52 | .022 | 82.1 | 87.8 | 81.2 | 91.3 | 90.0 | 87.7 | 1.06 | -- |
| 4124 | 16 | 5.0 | 33 | .019 | 79.7 | 85.7 | -- | 91.3 | 91.0 | 85.5 | 1.31 | -- |
| 4126 | 19 | -- | 30 | .024 | 77.8 | 83.6 | 74.3 | 89.5 | 91.1 | 82.9 | -- | -- |
| 4127 | 15 | 5.0 | 48 | .063 | 65.0 | 85.0 | 65.0 | 89.6 | 90.8 | 86.1 | -- | 2.76 |
| 4128 | 16 | 7.0 | 41 | .069 | 82.5 | 80.3 | 79.8 | 86.2 | 86.2 | 88.5 | -- | -- |
| 4129 | 17 | 5.0 | 30 | .035 | 72.8 | 86.5 | -- | 91.6 | 92.5 | 85.7 | -- | 3.10 |
| 4130 | 14 | 4.4 | 42 | .038 | 81.7 | 84.8 | 80.5 | 89.2 | 92.3 | 83.9 | 1.40 | -- |
| 4131 | 15 | 5.0 | 55 | .035 | 77.0 | 85.3 | 69.3 | 90.8 | 90.9 | 87.6 | -- | 2.60 |
| 4137 | 17 | 11.0 | 33 | .024 | 70.0 | 88.5 | 72.0 | 92.0 | 92.0 | 87.3 | 1.37 | 2.83 |
| 4140 | 17 | 8.8 | 52 | .031 | 76.1 | 84.5 | 78.0 | 88.3 | 92.1 | 83.1 | -- | 4.6 |
| 4141 | 18 | 6.0 | 40 | .031 | 74.0 | 84.8 | -- | 91.3 | 91.0 | 84.8 | -- | -- |
| 4142 | 18 | 6.0 | 42 | .021 | 77.8 | 85.3 | -- | 91.2 | 91.1 | 83.9 | -- | -- |
| 4146 | 15 | -- | 47 | .041 | 80.3 | 85.0 | 76.9 | 91.9 | 91.3 | 86.0 | -- | 2.75 |
| 4153 | 18 | 4.3 | 53 | .024 | 71.9 | 87.7 | -- | 93.7 | 92.8 | 87.7 | -- | -- |
| 4155 | 16 | 5.5 | 55 | .041 | 81.6 | 81.0 | 80.8 | 89.2 | 91.4 | 84.6 | 1.74 | -- |
| 4156 | 14 | 5.5 | 39 | .016 | 72.4 | 83.6 | -- | 91.3 | 93.1 | 81.9 | 1.74 | 3.14 |
| 4157 | 17 | 4.9 | 47 | .040 | 74.5 | 88.2 | -- | 95.7 | 92.2 | 87.3 | 1.84 | 2.90 |
| 4158 | 14 | 4.5 | -- | .045 | 60.2 | 85.8 | 59.6 | 89.5 | 90.5 | 86.0 | -- | -- |
| 4160 | 18 | -- | 48 | .040 | 73.1 | 90.4 | 73.5 | 93.6 | 91.1 | 89.1 | 1.82 | 2.79 |
| 4162 | 8 | 3.2 | 46 | .050 | 81.5 | 85.3 | 74.5 | 92.0 | 90.6 | 85.2 | -- | 4.5 |
| 4163 | 17.3 | 5.7 | 60 | .043 | 82.8 | 86.1 | 79.0 | 91.0 | (82.8) | (86.6) | -- | 4.5 |
| 4164(a) | 15 | 5.0 | 50 | .040 | 74.9 | 85.7 | 71.4 | 90.7 | 91.6 | 87.5 | 2.24 | -- |
| 4164(b) | 14 | 5.3 | 44 | .043 | 72.8 | 95.7 | 68.0 | 96.6 | 92.5 | 87.2 | 4.21 | -- |
| 4165 | 18 | 6.0 | 44 | .028 | 76.8 | 85.7 | -- | 89.9 | 91.2 | 84.3 | 1.85 | -- |
| 4168 | 17 | 7.0 | 61 | .042 | -- | 85.7 | -- | 89.6 | 91.1 | 85.3 | 1.44 | -- |
| 4171 | 14.4 | 5.0 | 47 | .034 | -- | -- | -- | 93.2 | 92.0 | 88.1 | 1.42 | -- |
| 4172 | 14 | 5.2 | 47 | .018 | -- | 82.8 | -- | 88.1 | 92.0 | 80.7 | 2.37 | -- |
| 4175 | 15 | 5.1 | 54 | .026 | -- | 86.2 | -- | 91.9 | 92.3 | 85.3 | 1.42 | -- |
| 4177 | 14 | 4.6 | 56 | .031 | 81.0 | 87.1 | 75.0 | 92.0 | 92.0 | 87.5 | 1.30 | -- |
| 4178 | 16 | 5.0 | 45 | .027 | 81.4 | 85.5 | -- | 90.4 | 93.2 | 86.3 | 1.71 | -- |
| 4179 | 15.4 | -- | 38 | .031 | 79.4 | 86.5 | -- | 90.2 | 90.1 | 85.6 | -- | -- |
| 4183 | 21 | 5.1 | 29 | .022 | (71.7) | (88.3) | -- | -- | 92.4 | 86.9 | 1.97 | -- |
| 4184 | 16 | 4.5 | 54 | .030 | 82.4 | 85.5 | 77.8 | 90.6 | 90.8 | 85.4 | 1.26 | -- |
| 4195 | 17.7 | 6.3 | 47 | .029 | 83.2 | 80.1 | 79.3 | 87.5 | 92.1 | 80.4 | 2.04 | -- |
| Average | 15.8 | 5.6 | -- | .034 | 76.0 | 85.3 | -- | 91.0 | 91.3 | 85.8 | 1.71 | 3.21 |
| Avg.1940 | 16.2 | 5.3 | -- | .035 | -- | 84.9 | -- | 90.7 | 91.5 | 85.5 | -- | -- |

Table 4

PROCESS DATA, NON-STEFFEN

| Sample Number | High Raw Sugar | | Low Raw Massecuite | | | | Low Raw Sugar | | | Carbon lbs per 100 sugar |
|---|---|---|---|---|---|---|---|---|---|---|
| | Wash Water | Purity | Brix | Pur. | Cu.Ft. per 100 Wht. | Cu.Ft. per 100 Raw Sug. | Wash Water | Purity | Where used | |
| 4103 | 6qts | 99.7 | 97.0 | 73.5 | -- | -- | 2qts | 92.2 | B.E. | 0 |
| 4105 | 10 | 98.0 | 96.0 | 73.8 | -- | 2.74 | 1.5 | 91.5 | B.E. | 0.38 |
| 4106 | 13 | 98.1 | 95.6 | 76.4 | -- | -- | 0 | 93.8 | H.R. | 0 |
| 4108 | 3 | 97.5 | 94.5 | 76.2 | 0.53 | 2.81 | 1.0 | 90.4 | B.E. | 0.05 |
| 4110 | 6 | 97.5 | 97.2 | 73.1 | -- | -- | 0.5 | 85.0 | B.E. | 0 |
| 4111 | 7 | 96.0 | 98.4 | 72.6 | 0.66 | -- | 2.0 | 89.1 | B.E. | 0 |
| 4112 | 2.5 | 97.0 | 94.3 | 73.4 | 0.43 | -- | 0 | 90.2 | -- | 0.08 |
| 4114 | 10 | 98.8 | 94.7 | 75.1 | -- | 2.80 | 2.0 | 93.2 | BE & SL | 0 |
| 4115 | 14 | 99.5 | 92.0 | 76.2 | 0.92 | 2.88 | 2.0 | 93.7 | B.E. | 0.14 |
| 4116 | 6 | 97.4 | 94.9 | 71.2 | 0.56 | 2.79 | 2.0 | 89.2 | B.E. | 0.12 |
| 4117 | 10 | 99.1 | 94.6 | 77.6 | 0.57 | 2.54 | 2.0 | 96.1 | B.E. | 0.16 |
| 4118 | 3 | 95.9 | 94.2 | 74.9 | -- | -- | 1.5 | 91.4 | B.E. | 0.14 |
| 4121 | 10 | 99.5 | 92.0 | 76.5 | -- | 3.07 | 0 | 92.1 | B.E. | 0.17 |
| 4122 | 9 | 97.8 | 97.7 | 72.3 | -- | -- | 2.0 | 89.3 | B.E. | 0 |
| 4123 | 4 | 97.9 | 93.9 | 75.9 | 0.87 | -- | 0.8 | 88.8 | B.E. | 0.29 |
| 4125 | 2 | 94.2 | 97.4 | 72.3 | 0.47 | -- | 1.0 | 86.7 | BE & HR | 0 |
| 4132 | 14 | 98.5 | 97.3 | 73.7 | 0.62 | -- | 0.8 | 88.6 | B.E. | 0 |
| 4133 | -- | -- | 94.5 | 74.3 | -- | 3.3 | 3.0 | 96.3 | S.L. | 0 |
| 4134 | 5.9 | 98.8 | 95.4 | 78.3 | -- | 2.4 | 0 | 91.8 | H.R. | 0 |
| 4135 | 10 | 98.8 | 98.1 | 74.8 | 0.68 | -- | 0.9 | 87.4 | H.R. | 0.10 |
| 4136 | 8 | 98.4 | 93.0 | 75.8 | -- | -- | 0.3 | 92.7 | H.R. | 0.17 |
| 4138 | 2.5 | 98.0 | 94.1 | 76.1 | -- | 6.1 | 3.5 | 96.3 | B.E. | 0.11 |
| 4139 | 2.5 | 96.6 | 95.7 | 72.5 | -- | 2.59 | 1.0 | 89.1 | B.E. | 0.10 |
| 4143 | 4 | 94.0 | 96.4 | 74.2 | -- | -- | 1.0 | 89.1 | B.E. | 0 |
| 4144 | 5 | 97.3 | 98.1 | 72.1 | 0.57 | -- | 1.0 | 87.0 | H.R. | 0.11 |
| 4145 | 6.3 | 98.2 | 92.5 | 78.4 | 1.86 | -- | 2.0 | 96.7 | B.E. | 0 |
| 4147 | 5 | 95.5 | 91.7 | 76.8 | -- | -- | 0 | -- | -- | 0.10 |
| 4149 | 9 | 98.2 | 91.7 | 77.3 | 0.50 | 3.11 | 2.25 | 92.6 | B.E. | 0.12 |
| 4150 | 6 | 98.4 | 96.3 | 58.8 | 0.54 | -- | 2.0 | 89.9 | BE & HR | 0 |
| 4151 | 8 | 97.1 | 91.6 | 75.9 | -- | -- | -- | 94.1 | B.E. | 0 |
| 4152 | -- | -- | 93.3 | 77.3 | -- | -- | 1.0 | 93.0 | B.E. | 0 |
| 4159 | 2 | 97.9 | 96.7 | 73.4 | -- | -- | 1.0 | 90.7 | B.E. | 0 |
| 4161 | 5 | 96.7 | 96.4 | 72.0 | -- | 3.74 | 2.0 | 89.9 | B.E. | 0.10 |
| 4166 | 14 | 97.6 | 94.2 | 75.9 | -- | 2.64 | 4.5 | 94.7 | S.L. | 0.12 |
| 4167 | 6 | 97.6 | 94.4 | 75.6 | 0.45 | 2.81 | 1.0 | 92.3 | B.E. | 0.08 |
| 4169 | 4 | 97.1 | 95.3 | 75.2 | 0.51 | -- | 2.0 | 93.5 | S.L. | 0.08 |
| 4173 | 8 | 99.0 | 98.1 | 74.4 | 0.74 | -- | 2.0 | 91.0 | B.E. | 0.21 |
| 4176 | 5.2 | 98.2 | 93.4 | 73.7 | -- | 2.85 | 1.0 | 90.9 | B.E. | 0.14 |
| 4180 | 8 | 96.4 | 96.5 | 75.3 | 0.69 | 2.72 | 1.5 | 90.3 | BE & HR | 0.03 |
| 4182 | 8 | 96.8 | 97.3 | 78.2 | -- | -- | 2.0 | 93.1 | B.E. | 0 |
| 4191 | -- | -- | 95.2 | 79.1 | 0.64 | -- | 1.0 | 95.2 | S.L. | 0.32 |
| 4194 | 2.3 | 97.0 | 94.6 | 75.7 | 0.57 | -- | 0 | 92.0 | B.E. | 0 |
| 4196 | -- | -- | 94.6 | 78.4 | 0.69 | -- | 1.0 | 94.6 | S.L. | 0.17 |
| Average | 6.9 | 97.6 | 95.2 | 74.5 | 0.68 | 3.05 | 1.4 | 91.4 | -- | 0.08 |
| AVG.1940 | -- | 97.4 | -- | -- | -- | -- | -- | 90.9 | -- | 0.09 |

Table 4

PROCESS DATA, STEFFEN

| Sample Number | High Raw Sugar | | Low Raw Massecuite | | | | Low Raw Sugar | | | Carbon, | Molasses |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wash Water | Purity | Brix | Pur. | Cu.Ft.per 100 Wht. | Cu.Ft.per 100 Raw Sug. | Wash Water | Purity | Where Used | lbs.per 100 sugar | Worked % beets |
| 4101 | 5 qts | 97.4 | 90.9 | 81.2 | 0.95 | -- | 4 qts | 96.5 | B.E. | 1.29 | 5.04 |
| 4102 | 12 | 99.4 | 95.1 | 77.2 | -- | -- | 1 | 93.5 | B.E. | 0.17 | 7.47 |
| 4104 | -- | -- | 92.2 | 81.5 | -- | 2.57 | 1 | 95.5 | B.E. | 0 | 3.56 |
| 4107 | 5 | 96.1 | 92.5 | 77.6 | -- | -- | 1 | 90.6 | B.E. | 0.06 | 4.99 |
| 4109 | 3 | 97.2 | 90.9 | 78.8 | -- | 3.14 | 3 | 95.7 | B.E. | 0 | 7.52 |
| 4113 | 5 | 98.1 | 92.8 | 79.8 | -- | -- | 12 | 95.8 | S.L. | 0.09 | 4.89 |
| 4119 | -- | 99.2 | 91.0 | 77.1 | -- | 3.84 | -- | 96.0 | B.E. | 0.18 | 6.93 |
| 4120 | 4 | 97.4 | 92.0 | 79.0 | -- | 2.45 | 2 | 95.6 | B.E. | 0.03 | 3.86 |
| 4124 | 2 | 95.2 | 93.3 | 75.7 | 0.65 | -- | 1 | 90.3 | B.E. | 0 | 5.06 |
| 4126 | 5 | -- | 94.2 | 71.2 | -- | -- | 1 | 97.0 | B.E. | 0 | 4.97 |
| 4127 | 4 | 98.2 | 92.2 | 75.8 | -- | 3.41 | 2 | 96.5 | B.E. | 0.19 | 5.03 |
| 4128 | 3 | 97.9 | 93.1 | 75.4 | -- | -- | 4 | 95.1 | BE & SL | 0.14 | 7.80 |
| 4129 | 4 | 97.4 | 94.3 | 77.4 | -- | 2.81 | 1 | 93.6 | B.E. | 0.10 | 6.73 |
| 4130 | 4 | 94.8 | 96.1 | 75.5 | -- | 3.8 | 1.5 | 89.0 | B.E. | 0 | 4.50 |
| 4131 | -- | 99.6 | 91.2 | 79.2 | -- | 2.98 | -- | 96.9 | B.E. | 0.26 | 5.76 |
| 4137 | 10 | 98.3 | 93.2 | 78.6 | -- | 2.86 | 0 | 92.9 | B.E. | 0.06 | 6.44 |
| 4140 | 3 | 97.7 | 92.2 | 74.8 | -- | -- | 1 | 92.0 | B.E. | 0.13 | 5.62 |
| 4141 | 3 | 96.8 | 93.0 | 76.1 | -- | -- | 1.5 | 88.2 | B.E. | 0 | 4.97 |
| 4142 | 5 | 97.4 | 93.1 | 74.6 | -- | -- | 1 | 89.6 | B.E. | 0 | 4.68 |
| 4146 | -- | 99.3 | 91.9 | 77.2 | -- | 2.45 | -- | 93.2 | B.E. | 0.15 | 7.56 |
| 4153 | 7 | 98.4 | 93.5 | 79.7 | 0.49 | -- | 0 | 91.5 | B.E. | 0.07 | 4.36 |
| 4155 | 5 | 97.8 | 91.6 | 75.9 | -- | -- | 2 | 94.8 | B.E. | 0 | 6.84 |
| 4156 | 6 | 98.1 | 97.4 | 71.9 | 0.69 | 3.72 | 1.5 | 88.8 | B.E. | 0.10 | 3.97 |
| 4157 | 12 | 99.6 | 91.6 | 78.6 | -- | 2.83 | 2 | 96.1 | BE & SL | 0.09 | 9.67 |
| 4158 | 10 | 95.0 | 91.0 | 76.2 | -- | -- | 3 | 93.0 | B.E. | 0.20 | 6.13 |
| 4160 | 10 | 99.3 | 92.6 | 80.7 | -- | 3.28 | 3 | 95.8 | B.E. | 0.20 | 6.18 |
| 4162 | 5 | 98.5 | 90.8 | 80.4 | -- | 5.3 | 4 | 97.2 | B.E. | 0.21 | 5.92 |
| 4163 | 6 | 98.2 | 91.8 | 80.5 | -- | 4.03 | 4 | 95.5 | B.E. | 0.21 | 7.37 |
| 4164(a) | 6 | 98.7 | 94.3 | 77.2 | -- | 2.62 | 5 | 94.5 | H.R. | 0.10 | 6.00 |
| 4164(b) | 5 | 98.5 | 95.3 | 77.8 | -- | 2.50 | 4 | 93.5 | H.R. | 0.05 | 12.31 |
| 4165 | 6 | 96.7 | 93.9 | 74.0 | 0.57 | -- | 0.8 | 87.6 | H.R. | 0 | 4.49 |
| 4168 | 4 | 96.2 | 92.9 | 77.5 | 0.68 | -- | 2 | 91.4 | B.E. | 1.36 | 5.81 |
| 4171 | 6.3 | 98.1 | 92.8 | 79.4 | 1.72 | -- | 4.5 | 96.3 | B.E. | 0 | 6.80 |
| 4172 | 5 | 93.9 | 95.6 | 73.7 | -- | 3.58 | 5 | 92.3 | B.E. | 0 | 5.16 |
| 4175 | 6 | 98.8 | 95.6 | 75.4 | 0.39 | -- | 2 | 94.4 | H.R. | 0.07 | 5.00 |
| 4177 | 6 | 98.0 | 93.0 | 77.9 | -- | 2.70 | 2 | 93.4 | S.L. | 0 | 6.69 |
| 4178 | 12 | 97.8 | 95.3 | 77.3 | -- | 5.1 | 0 | 92.9 | H.R. | 0.14 | 6.58 |
| 4179 | 8 | 96.1 | 91.3 | 78.5 | -- | -- | 2 | 91.5 | B.E. | 0.08 | 5.25 |
| 4183 | 12 | 98.4 | 92.7 | 80.1 | 1.76 | -- | 1.8 | 97.4 | S.L. | 0 | 5.85 |
| 4184 | 5 | 97.5 | 92.2 | 77.9 | 0.77 | -- | 1 | 93.6 | B.E. | 0.08 | 5.99 |
| 4195 | 3 | 97.6 | 91.9 | 77.9 | 0.84 | -- | 0 | 92.6 | B.E. | 0.09 | 5.40 |
| Average | 6.1 | 97.7 | 93.0 | 77.3 | 0.86 | 3.35 | 2.3 | 93.6 | | 0.14 | 5.99 |
| Avg.1940 | -- | 97.7 | -- | -- | -- | -- | -- | 93.3 | | 0.10 | 6.25 |

## OPERATING DATA

### 1. Quality of Beets and Diffusion Juices

In certain areas the sucrose in beets and diffusion juice purities was especially low when compared with the previous campaign. The low sucrose was in part the result of plentiful rain during the harvest period so that the beets were at a condition of high water content. This was evident in the excess tonnage yield over early estimates and also in the rather slight drop in juice purity as compared with the larger drop in sucrose content. Diffusion juice purity usually has little effect on sugar quality, as in general factory operations are adjusted to produce a white massecuite of a normal high purity. The important effect of juice purity is rather on molasses production. There is some evidence that moderately low juice purities may even contribute to a better sugar quality, possibly because of the greater dilution of juice solids by the increased proportion of remelt sugars resulting from the effort to maintain the white massecuite purity at a normal value.

### 2. Liming and Carbonation

The total lime requirements were much the same as in 1940 but showed some increase in areas where juice purity was lower than normal. The same observation may be made for the use of soda ash, i.e., where the juice purity was high the use of soda ash decreased and visa versa. The lower requirements for lime noted in factories operating on beets from irrigated areas appears to be associated with a lower proportion of organic non-sugars in juices from such beets. This is judged from the contrasts in the composition of the sugars and the results obtained by others on the glutamic acid content of the Steffen wastes in different areas. The analyses of the white massecuites and molasses samples should add to our information along this line.

### 3. Sulphuring

The degree of sulphuring remained essentially constant on the average and, as will be noted later, the sulphites in sugar also remained the same. Much study of the data of past years shows that the degree of sulphuring is on the average directly related to sulpites in sugar, but dealing with individual factories using the same apparent amount of sulphur there may be a sharp contrast in the sulphites remaining in the sugar. The sulphitation used has a quite direct effect on sugar reflectance, color in solution and the color increase observed in the barley candy.

During this campaign nine factories sulphured thick juice only, thirteen sulphured both thin and thick juices and the rest sulphured the thin juice only. About 57% of the factories used less than 0.4 lbs. of sulphur per ton of beets, this continues the trend to lower sulphuring noted in last year's report.

### 4. pH Change from Thin Juice to Thick Juice

This subject was commented on in the previous report but some additional observations may be made. Considering the average situation in the different areas, it is seen that in the humid regions, where as judged from sugar composition the ash alkalinities are higher, the pH change from thin juice to thick is slight. In the arid areas the general trend is for the pH of thick juice to be considerably higher than in the thin juice. This increase is greater in non-Steffen factories and may be absent in the corresponding Steffen factories. It is thought by many that the increase in pH during evaporation is due to decomposition of bicarbonates and this probability is strengthened by the fact that the pH of the thin juice averages only 8.2 in the areas where large increases in pH are observed and is 8.6 in the areas where the increase is small or lacking.

### 5. Standard Liquor and White Massecuite

The trend toward filtration of standard liquor at high density continues upward. About 25% of the factories filtered at 70° Brix or above, an additional

50% at between 65° and 70° Brix, and only two factories at densities below 60° Brix. One third of the factories are now using double filtration and nearly this proportion have adopted top discharge presses. In a general way these changes appear to have reduced the silica content of the sugars but did not show an improvement in sugar solution clarity.

The average purity of the white massecuite was increased in all areas. This may be correlated with the further decrease in sugar ash which will be noted later. Comparing with the campaign of 1936 when the white massecuite purity averaged one degree purity lower than during the past campaign, the ash in sugar has been reduced by one-third and likewise the sugar color in solution. In this earlier year some 17% of the white massecuites were below 90° purity and only 14% were over 92° purity. In the past year massecuites below 90° purity were only 4% of the total, and 62% were of 92° purity or over.

As usual the Brix of the white massecuites of the non-Steffen factories averaged slightly higher than at Steffen factories. This difference is partly explained by the slightly higher purity of the Steffen massecuites but also leads to a lower average yield of sugar in the bag per cu. ft. of massecuite. The non-Steffen yield per cu. ft. of massecuite was 34.4 lbs. and the Steffen yield 32.8 lbs. Individually there are wide variations between factories, the cu.ft. of massecuite per 100 lbs. of sugar ranging from 2.24 up to 3.86, the corresponding yields per cu.ft. being 44.6 and 25.9 lbs., respectively.

## 6. Washing of White Sugar

The amount of wash water used per 100 lbs. of sugar shows a small increase over last year in spite of some factories using a reduced quantity as a result of using superheated water. The slightly higher high wash purity may be due to the increased washing. The custom of reintroducing the high wash into the standard liquor and white pan is only excepted at three non-Steffen and nine Steffen factories where a part or all of the high wash is added to the high raw pan. The high green purities averaged the same as last year, namely 85.3°, which is about 2° below diffusion juice purity.

## 7. Raw Massecuites and Remelt Sugars

While, on the average, high raw massecuites are below diffusion juice in purity there are numbers of instances where they are above the juice value. The relation between high raw massecuite purity and diffusion juice purity may give a general idea of the proportion of remelt sugars to white sugars. In the question regarding the amounts of high raw and low raw sugar as percentages of the white sugar produced, it was hoped to obtain rather direct information on this point, namely the proportion of sugar recrystallized at different factories. This is undoubtedly an important factor in white sugar quality. It is somewhat the same as saying that the white massecuite purity is important, as it is, but it includes more than just that for it appears that some of the non-sugars which affect sugar quality are not present in sufficient quantities to materially alter the purity but their reduction in concentration is still important. The information supplied was incomplete partly because the questions were so stated that more than one interpretation was possible. As well as may be judged at present, the amounts of high raw as percent of white sugar may vary from 14% to 100% and the amount of low raw from 7% to 80%.

Of course the raw sugar purity is also a factor in the final white sugar quality. High raw sugar purities averaged very slightly higher than in 1940 and low raw sugars showed a somewhat greater improvement. Low raw sugar is reintroduced into the standard liquor in some eight factories, in thirteen others it is used in the high raw pan, and in the others it is reintroduced at the beet end ahead of liming or at first or second carbonation.

### 8. Use of Activated Carbon

Carbon is used at about two-thirds of the factories. The amount used at non-Steffen factories (where used) averaged 0.12 lbs. per 100 of white sugar. At Steffen factories the average was 0.22 lbs.

### 9. Storage of Beets

As work is being instituted to determine if some of the sugar losses occurring in stored beets are preventable, it is of interest to summarize the data supplied regarding the extent of storage practiced. The picture for the 1941 campaign is considerably affected by the crop being below some years in tonnage. It is found that roughly 25% or about 2.5 million tons were stored over 30 days and an equal amount or more was processed more than 5 days after harvesting. The very tentative observation that may be made on the research carried out this past season is the indication that inversion is the primary reaction causing loss of sucrose in sound beets and this is quite susceptible to the amount of moisture lost. Respiration is thought to be the secondary reaction consuming the reducing sugars; the balance between inversion and respiration determines the purity change. If this working hypothesis were correct then the maintenance of normal moisture content in the stored beets would reduce sugar losses. Also the losses due to spoilage are possibly preventable so it is hoped that some progress in reducing sugar losses during storage will be made.

### 10. Summary

Advances in operating technique have continued with maintenance of high standards in the chemical processing and in the mechanical equipment. The increased use of double filtration of standard liquor, top discharge presses high speed centrifugals, superheated water for washing the white sugar, and the continued improvement in white pan purities and care in sugar boiling all contribute to the production of a uniformly high quality sugar.

# STUDIES OF THE SUGARS

## 1. Ash Content

The ash obtained by simple ignition at 550°C. which for convenience is called the carbonate ash, was determined in quadruplicate. The average ash, both non-Steffen and Steffen, showed a significant decrease below the 1940 results. (Most of 'b' samples and numbers 4190-4196 are not included in the averages in any of the tables.) Individually, at two-thirds of the factories the sugars showed a decrease in ash and the remainder were constant or increased above the 1940 values. The drop in average ash is equal to that observed in 1940 as compared with 1939. The general average in 1939 was 0.0110%, in 1940 it was 0.100% and this year 0.0091%. Going back five years to 1936, it is noted that in that year only 5% of the sugars were below 0.0075% in ash and 80% were over 0.0100% ash. This year 30% of the sugars are below the 0.0075% ash and only 34% are over the 0.0100% mark. As was noted previously, the improvement in white pan purity in this interval was by 1°. Other advances in sugar boiling and centrifugal work were undoubtedly contributing factors in this striking decrease in sugar ash.

The sulphated ashes were again determined as it is felt that this type of ash comes nearer to representing the salt content in the sugar. It is also the basis for the calculation of approximate salt content. While on the average the carbonate ash is 24% below the sulphated ash, in the case of individual sugars it may be as much as 30% lower and as little as 14% below sulphated ash. Sulphated ash is essentially the weight of the sulphates of the total bases (metals) present plus the silica.

Specific conductivity was again determined on all samples, using a concentration of 30 grams of sugar made up to 100 cc. with conductivity water. The factors relating specific conductivity and carbonate ash were calculated as the reciprocal of the factors as given in the 1940 report and expressed as whole

### Table 5
### Ash, Salts and Mineral Composition
### Non-Steffen

| Sample Number | Carb. Ash % | Sulp. Ash % | Spec. Cond. X 10$^6$ | Mineral Constituents | | | | | Org. Acid p.p.m. | Estimated Salts | | | pH sugar sol'n |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $SO_2$ | $SO_3$ | Cl | CaO | $SiO_2$ | | Total % | Inorg., % tot. | Org., % tot. | |
| | | | | | (p.p.m.) | | | | | | | | |
| 4103 | 0.0069 | 0.0090 | 17.1 | 12 | 4 | 5 | 1 | 5 | 32 | 0.0100 | 47 | 53 | 6.58 |
| 4105 | .0065 | .0081 | 19.5 | 4 | 12 | 1 | 4 | 7 | 44 | .0104 | 41 | 59 | 7.20 |
| 4106(a) | .0087 | .0118 | 24.2 | 3 | 8 | 4 | 5 | 0 | 76 | .0146 | 22 | 78 | 7.07 |
| (b) | .0121 | — | 31.8 | 4 | - | 10 | 4 | - | - | - | - | - | 7.45 |
| 4108 | .0070 | .0092 | 17.7 | 4 | 4 | 2 | 3 | 10 | 54 | .0112 | 29 | 71 | 7.22 |
| 4110 | .0063 | .0083 | 18.1 | 8 | 8 | 17 | 5 | 6 | 0 | .0077 | 100 | - | 6.75 |
| 4111 | .0103 | .0143 | 27.4 | 7 | 27 | 2 | 4 | 20 | 52 | .0169 | 56 | 44 | 6.83 |
| 4112 | .0107 | .0128 | 29.7 | 19 | 12 | 6 | 4 | 2 | 34 | .0137 | 63 | 37 | 6.22 |
| 4114 | .0080 | .0103 | 20.0 | 3 | 4 | 4 | 5 | 1 | 70 | .0129 | 19 | 81 | 7.10 |
| 4115 | .0088 | .0123 | 23.2 | 10 | 7 | 2 | 6 | 11 | 80 | .0163 | 32 | 68 | 7.13 |
| 4116 | .0096 | .0124 | 23.5 | 4 | 10 | 3 | 6 | 5 | 80 | .0157 | 26 | 74 | 6.43 |
| 4117 | .0049 | .0070 | 13.4 | 7 | 5 | 5 | 3 | 9 | 20 | .0077 | 62 | 38 | 6.70 |
| 4118 | .0082 | .0117 | 21.1 | 2 | 9 | 1 | 8 | 7 | 98 | .0168 | 19 | 81 | 7.60 |
| 4121 | .0083 | .0108 | 21.3 | 14 | 6 | 7 | 1 | 10 | 22 | .0109 | 69 | 31 | 6.46 |
| 4122 | .0077 | .0096 | 22.3 | 12 | 10 | 9 | 4 | 0 | 18 | .0102 | 73 | 27 | 6.86 |
| 4123 | .0076 | .0099 | 19.4 | 3 | 5 | 0 | 1 | 7 | 76 | .0133 | 18 | 82 | 7.17 |
| 4125 | .0080 | .0094 | 17.7 | 8 | 7 | 7 | 1 | 5 | 38 | .0109 | 50 | 50 | 6.71 |
| 4132 | .0068 | .0079 | 17.7 | 12 | 11 | 6 | 4 | 0 | 4 | .0076 | 92 | 8 | 6.98 |
| 4133 | .0090 | .0122 | 23.8 | 12 | 7 | 2 | 10 | 7 | 72 | .0155 | 34 | 66 | 6.83 |
| 4134 | .0065 | .0082 | 14.2 | 2 | 6 | 2 | 13 | 2 | 60 | .0109 | 21 | 79 | 6.86 |
| 4135 | .0078 | .0108 | 24.6 | 7 | 9 | 5 | 4 | 1 | 66 | .0139 | 34 | 66 | 6.91 |
| 4136 | .0106 | .0125 | 27.4 | 8 | 7 | 6 | 2 | 6 | 76 | .0160 | 33 | 67 | 6.44 |
| 4138 | .0074 | .0099 | 19.0 | 2 | 5 | 1 | 8 | 0 | 76 | .0130 | 14 | 86 | 6.52 |
| 4139 | .0143 | .0197 | 37.5 | 4 | 11 | 2 | 13 | 5 | 150 | .0261 | 16 | 84 | 7.58 |
| 4143(a) | .0067 | .0091 | 20.4 | 7 | 8 | 4 | 1 | 7 | 50 | .0115 | 40 | 60 | 7.10 |
| (b) | .0062 | — | 18.1 | 3 | - | 5 | 7 | - | - | - | - | - | 7.75 |
| 4144(a) | .0061 | .0076 | 16.1 | 10 | 6 | 6 | 2 | 4 | 26 | .0089 | 61 | 39 | 6.74 |
| (b) | .0065 | .0085 | 18.4 | 13 | 6 | 7 | 3 | 2 | 29 | .0099 | 57 | 43 | 6.66 |
| 4145(a) | .0063 | .0103 | 18.2 | 3 | 6 | 6 | 8 | 0 | 66 | .0129 | 26 | 74 | 6.48 |
| (b) | .0071 | — | 18.8 | 3 | - | - | 8 | - | - | - | - | - | 7.34 |
| 4147 | .0194 | .0232 | 51.0 | 2 | 11 | 2 | 11 | 4 | 190 | .0314 | 12 | 88 | 6.88 |
| 4149 | .0096 | .0116 | 23.8 | 28 | 12 | 4 | 4 | 2 | 0 | .0107 | 100 | 0 | 6.70 |
| 4150 | .0059 | .0085 | 16.7 | 8 | 5 | 7 | 1 | 6 | 34 | .0100 | 51 | 49 | 6.40 |
| 4151 | .0085 | .0118 | 23.8 | 12 | 8 | 4 | 11 | 7 | 50 | .0135 | 46 | 54 | 6.70 |
| 4152 | .0117 | .0155 | 24.8 | 12 | 4 | 2 | 5 | 48 | 54 | .0172 | 53 | 47 | 6.57 |
| 4159 | .0114 | .0144 | 28.5 | 39 | 11 | 5 | 5 | 0 | 0 | .0132 | 100 | 0 | 6.51 |
| 4161 | .0079 | .0107 | 21.4 | 20 | 6 | 15 | 1 | 3 | 4 | .0101 | 94 | 6 | 6.31 |
| 4166 | .0102 | .0149 | 19.2 | 2 | 4 | 1 | 8 | 15 | 132 | .0215 | 14 | 86 | 7.21 |
| 4167 | .0060 | .0073 | 15.9 | 5 | 3 | 1 | 2 | 4 | 48 | .0093 | 25 | 75 | 7.00 |
| 4169 | .0102 | .0135 | 28.5 | 16 | 12 | 6 | 3 | 5 | 50 | .0154 | 53 | 47 | 6.53 |
| 4173 | .0115 | .0147 | 31.6 | 11 | 10 | 21 | 6 | 7 | 41 | .0161 | 60 | 40 | 6.85 |
| 4176 | .0037 | .0050 | 11.1 | 4 | 5 | 4 | 1 | 4 | 16 | .0055 | 58 | 42 | 6.25 |
| 4180 | .0082 | .0110 | 23.0 | 8 | 9 | 5 | 4 | 9 | 44 | .0126 | 48 | 52 | 6.68 |
| 4182 | .0069 | .0080 | 19.2 | 11 | 6 | 11 | 1 | 7 | 4 | .0075 | 92 | 8 | 6.65 |
| 4191 | .0161 | .0217 | 41.1 | 14 | 14 | 8 | 8 | 7 | 116 | .0259 | 34 | 66 | 6.79 |
| 4194 | .0087 | .0116 | 21.2 | 6 | 6 | 3 | 7 | 12 | 78 | .0153 | 28 | 72 | 6.76 |
| 4196 | .0252 | .0323 | 61.0 | 11 | 18 | 6 | 8 | 7 | 214 | .0406 | 21 | 79 | 6.65 |
| Average | 0.0085 | 0.0111 | 22.3 | 9 | 8 | 5 | 5 | 6 | 53 | .0132 | 42 | 58 | 6.84 |
| Avg.1940 | 0.0093 | .0118 | 23.8 | 9 | 8 | 7 | 3 | 7 | 56 | .0140 | 42 | 58 | — |

## Table 5
## Ash, Salts and Mineral Composition
## Steffen

| Sample Number | Carb. Ash | Sulp. Ash | Spec. Cond. X $10^6$ | Mineral Constituents (p.p.m.) | | | | | Org. Acid | Estimated Salts | | | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $SO_2$ | $SO_3$ | Cl | CaO | $SiO_2$ | p.p.m. | Total % | Inorg. % tot. | Org. % tot | Sugar Sol'n. |
| 4101 | 0.0083 | 0.0108 | 19.4 | 2 | 4 | 1 | 7 | 0 | 96 | 0.0152 | 10 | 90 | 7.10 |
| 4102 | .0062 | .0079 | 14.5 | 2 | 5 | 1 | 3 | 0 | 64 | .0109 | 16 | 84 | 7.45 |
| 4104 | .0144 | .0188 | 37.8 | 8 | 5 | 7 | 5 | 0 | 130 | .0238 | 19 | 81 | 6.93 |
| 4107 | .0069 | .0080 | 19.4 | 8 | 2 | 3 | 1 | 3 | 42 | .0095 | 34 | 66 | 6.95 |
| 4109 | .0099 | .0133 | 25.6 | 3 | 21 | 1 | 8 | 6 | 68 | .0160 | 38 | 62 | 6.62 |
| 4113 | .0095 | .0135 | 21.2 | 3 | 4 | 0 | 4 | 3 | 120 | .0190 | 10 | 90 | 6.82 |
| 4119 | .0118 | .0155 | 29.3 | 3 | 6 | 1 | 9 | 13 | 118 | .0206 | 17 | 83 | 6.61 |
| 4120 | .0073 | .0092 | 18.6 | 9 | 3 | 1 | 5 | 4 | 68 | .0127 | 25 | 75 | 7.06 |
| 4124 | .0102 | .0123 | 24.9 | 14 | 7 | 5 | 5 | 12 | 54 | .0146 | 47 | 53 | 6.60 |
| 4126 | .0086 | .0117 | 24.3 | 6 | 18 | 4 | 4 | 3 | 50 | .0137 | 47 | 53 | 6.45 |
| 4127 | .0186 | .0247 | 45.0 | 5 | 11 | 8 | 9 | 6 | 172 | .0313 | 19 | 81 | 7.09 |
| 4128(a) | .0161 | .0210 | 40.4 | 6 | 8 | 12 | 4 | 7 | 135 | .0263 | 24 | 76 | 6.64 |
| (b) | .0213 | .0278 | 56.8 | 9 | 7 | 4 | 7 | 12 | 212 | .0366 | 15 | 85 | 6.96 |
| 4129 | .0097 | .0128 | 23.3 | 6 | 5 | 7 | 4 | 6 | 80 | .0161 | 28 | 72 | 6.25 |
| 4130 | .0101 | .0127 | 29.0 | 7 | 13 | 10 | 1 | 2 | 52 | .0144 | 47 | 53 | 7.18 |
| 4131 | .0119 | .0152 | 30.2 | 11 | 7 | 9 | 5 | 10 | 78 | .0183 | 38 | 62 | 6.48 |
| 4137 | .0102 | .0140 | 26.5 | 9 | 7 | 2 | 6 | 2 | 94 | .0179 | 24 | 76 | 6.69 |
| 4140 | .0131 | .0185 | 32.2 | 14 | 8 | 14 | 12 | 5 | 92 | .0218 | 39 | 61 | 6.62 |
| 4141 | .0105 | .0143 | 26.1 | 8 | 9 | 4 | 6 | 4 | 86 | .0177 | 29 | 71 | 6.48 |
| 4142 | .0080 | .0108 | 23.7 | 8 | 13 | 3 | 3 | 1 | 52 | .0129 | 42 | 58 | 6.68 |
| 4146 | .0083 | .0120 | 17.9 | 5 | 7 | 1 | 7 | 4 | 84 | .0155 | 21 | 79 | 6.58 |
| 4153 | .0063 | .0082 | 15.8 | 4 | 3 | 13 | 4 | 5 | 26 | .0086 | 55 | 45 | 6.45 |
| 4155 | .0104 | .0128 | 25.3 | 8 | 7 | 3 | 7 | 1 | 78 | .0157 | 27 | 73 | 6.59 |
| 4156(a) | .0062 | .0082 | 18.8 | 9 | 5 | 10 | 3 | 5 | 24 | .0092 | 62 | 38 | 6.31 |
| (b) | .0072 | .0091 | 21.3 | 9 | 7 | 12 | 3 | 7 | 26 | .0101 | 64 | 36 | 6.42 |
| 4157 | .0084 | .0105 | 19.1 | 5 | 15 | 2 | 3 | 14 | 52 | .0131 | 45 | 55 | 6.34 |
| 4158 | .0084 | .0113 | 23.5 | 2 | 3 | 0 | 8 | 2 | 104 | .0162 | 8 | 92 | 7.18 |
| 4160 | .0140 | .0180 | 38.0 | 12 | 10 | 22 | 4 | 4 | 80 | .0211 | 46 | 54 | 6.58 |
| 4162 | .0086 | .0121 | 23.4 | 4 | 4 | 2 | 4 | 8 | 90 | .0160 | 21 | 79 | 6.62 |
| 4163 | .0109 | .0141 | 29.2 | 2 | 3 | 1 | 6 | 10 | 122 | .0198 | 12 | 88 | 6.71 |
| 4164(a) | .0053 | .0075 | 14.0 | 3 | 4 | 3 | 5 | 2 | 62 | .0107 | 21 | 79 | 6.04 |
| (b) | .0025 | .0032 | 6.1 | 2 | 0 | 0 | 6 | 2 | 26 | .0044 | 15 | 85 | 6.95 |
| 4165 | .0084 | .0113 | 24.1 | 8 | 8 | 2 | 3 | 0 | 78 | .0151 | 26 | 74 | 6.88 |
| 4168 | .0132 | .0180 | 32.9 | 10 | 14 | 2 | 4 | 4 | 110 | .0224 | 28 | 72 | 7.33 |
| 4171 | .0067 | .0091 | 17.2 | 2 | 5 | 2 | 5 | 6 | 72 | .0126 | 23 | 77 | 6.78 |
| 4172 | .0096 | .0130 | 26.0 | 12 | 12 | 7 | 2 | 0 | 56 | .0150 | 46 | 54 | 6.57 |
| 4175 | .0118 | .0142 | 29.7 | 7 | 12 | 9 | 7 | 0 | 70 | .0165 | 37 | 63 | 6.65 |
| 4177 | .0091 | .0109 | 24.3 | 4 | 8 | 5 | 4 | 1 | 62 | .0131 | 29 | 71 | 6.92 |
| 4178 | .0078 | .0108 | 24.1 | 4 | 5 | 16 | 2 | 0 | 54 | .0128 | 40 | 60 | 6.95 |
| 4179 | .0108 | .0134 | 25.3 | 6 | 8 | 1 | 11 | 0 | 110 | .0188 | 17 | 83 | 6.33 |
| 4183 | .0065 | .0085 | 15.7 | 4 | 3 | 5 | 4 | 6 | 56 | .0110 | 31 | 69 | 6.28 |
| 4184 | .0103 | .0152 | 27.9 | 10 | 6 | 8 | 3 | 10 | 90 | .0191 | 33 | 67 | 6.80 |
| 4190 | .0066 | .0095 | 19.2 | 1 | 2 | 1 | 3 | 1 | 82 | .0132 | 8 | 92 | 7.78 |
| 4195 | .0113 | .0145 | 26.8 | 7 | 6 | 8 | 9 | 12 | 84 | .0180 | 32 | 68 | 6.35 |
| Average | .0096 | .0128 | 24.8 | 6 | 7 | 5 | 5 | 4 | 78 | .0160 | 28 | 72 | 6.71 |
| Av.1940 | .0106 | .0136 | 26.4 | 6 | 8 | 7 | 4 | 7 | 82 | .0170 | 31 | 69 | — |

## Table 6
## Color and Turbidity
## Non-Steffen

| Sample Number | Sugar Solution | | | | Barley Candy Solution | | | |
|---|---|---|---|---|---|---|---|---|
| | Color | | Turbidity | | Color | | Turbidity | |
| | B-K Index | Filt.N-W $(-\log t)10^3$ | B-K Index | Filt.N-W $(-\log t)10^3$ | B-K Index | Filt.N-W $(-\log t)10^3$ | B-K Index | Filt.N-W $(-\log t)10^3$ |
| 4103 | 7.3 | 1.8 | 5.8 | 1.6 | 6.1 | 14.8 | 0.9 | 8.0 |
| 4105 | 4.6 | 0.6 | 7.6 | 2.4 | 10.4 | 23.8 | 1.4 | 10.3 |
| 4106(a) | 6.7 | 0.7 | 5.4 | 2.7 | 8.0 | 24.7 | 2.2 | 13.0 |
| (b) | 5.9 | 0.8 | 4.0 | 1.8 | 9.8 | 21.9 | 0.6 | 7.6 |
| 4108 | 6.2 | 0.7 | 5.0 | 3.3 | 8.6 | 23.5 | 2.2 | 13.6 |
| 4110 | 4.7 | 0.7 | 6.3 | 2.8 | 5.3 | 13.1 | 1.1 | 11.8 |
| 4111 | 5.7 | 0.6 | 7.0 | 2.0 | 7.2 | 14.5 | 0.6 | 10.6 |
| 4112 | 13.7 | 0.2 | 27.4 | 14.2 | 16.8 | 31.5 | 9.0 | 39.6 |
| 4114 | 7.8 | 1.1 | 5.3 | 2.9 | 13.0 | 29.5 | 2.8 | 19.2 |
| 4115 | 8.2 | 0.6 | 10.0 | 3.3 | 9.5 | 22.9 | 2.0 | 10.6 |
| 4116 | 12.5 | 2.5 | 33.0 | 15.0 | 12.8 | 31.1 | 3.8 | 19.8 |
| 4117 | 5.5 | 0.8 | 15.0 | 5.4 | 7.9 | 9.1 | 5.4 | 27.3 |
| 4118 | 10.1 | 0.4 | 12.7 | 6.4 | 12.8 | 25.1 | 3.8 | 19.5 |
| 4121 | 7.0 | 0.9 | 11.6 | 3.9 | 10.0 | 19.5 | 1.9 | 14.5 |
| 4122 | 6.8 | 1.6 | 7.3 | 2.7 | 8.4 | 21.5 | 2.6 | 17.3 |
| 4123 | 6.7 | 1.4 | 5.9 | 1.6 | 8.9 | 20.7 | 1.6 | 10.0 |
| 4125 | 4.4 | 0.5 | 5.3 | 3.8 | 6.4 | 17.0 | 1.0 | 13.9 |
| 4132 | 4.8 | 0.2 | 5.5 | 1.5 | 9.3 | 23.5 | 2.5 | 14.2 |
| 4133 | 15.7 | 3.3 | 50.5 | 19.4 | 6.7 | 22.2 | 7.6 | 21.0 |
| 4134 | 8.2 | 1.5 | 9.4 | 4.5 | 5.8 | 20.1 | 2.4 | 12.4 |
| 4135 | 6.6 | 1.8 | 7.8 | 3.3 | 13.9 | 32.8 | 2.5 | 16.5 |
| 4136 | 6.9 | 1.8 | 7.4 | 2.0 | 12.0 | 28.9 | 1.5 | 14.2 |
| 4138 | 14.9 | 5.1 | 15.4 | 7.3 | 14.9 | 34.1 | 2.8 | 21.7 |
| 4139 | 11.2 | 2.7 | 10.0 | 3.3 | 13.0 | 29.5 | 1.6 | 18.5 |
| 4143(a) | 6.0 | 1.6 | 6.4 | 1.9 | 9.1 | 14.3 | 0.6 | 10.0 |
| (b) | 7.6 | 2.4 | 12.7 | 5.1 | 8.9 | 20.1 | 0.8 | 10.9 |
| 4144(a) | 4.1 | 1.0 | 11.0 | 4.1 | 6.5 | 15.2 | 1.1 | 11.2 |
| (b) | 4.9 | 1.1 | 7.8 | 2.4 | 7.4 | 10.9 | 2.3 | 11.8 |
| 4145(a) | 10.1 | 1.8 | 9.7 | 5.2 | 11.3 | 25.1 | 2.5 | 17.9 |
| (b) | 8.8 | 2.5 | 7.2 | 3.0 | 6.5 | 15.5 | 0.4 | 8.5 |
| 4147 | 20.0 | 5.4 | 21.3 | 8.9 | 19.3 | 49.1 | 6.5 | 31.2 |
| 4149 | 7.3 | 0.8 | 11.6 | 5.5 | 9.4 | 19.7 | 2.5 | 20.1 |
| 4150 | 4.1 | 2.1 | 8.3 | 2.0 | 7.0 | 14.8 | 0.8 | 8.2 |
| 4151 | 12.7 | 2.9 | 16.2 | 7.2 | 17.8 | 41.6 | 5.4 | 31.5 |
| 4152 | 14.8 | 2.3 | 21.6 | 9.5 | 13.9 | 29.0 | 3.6 | 24.7 |
| 4159 | 3.0 | 0.4 | 6.4 | 2.9 | 12.2 | 30.8 | 2.5 | 11.2 |
| 4161 | 11.1 | 1.8 | 18.5 | 8.3 | 8.9 | 17.9 | 4.2 | 26.7 |
| 4166 | 17.3 | 2.5 | 7.6 | 3.7 | 11.4 | 24.1 | 2.6 | 16.7 |
| 4167 | 3.0 | 0.6 | 5.4 | 1.6 | 6.1 | 16.7 | 1.3 | 10.6 |
| 4169 | 8.7 | 2.0 | 7.2 | 2.9 | 15.8 | 39.3 | 2.3 | 18.6 |
| 4173 | 7.3 | 2.2 | 11.5 | 4.2 | 14.2 | 21.6 | 21.4 | 54.3 |
| 4176 | 7.0 | 1.8 | 10.6 | 3.0 | 7.4 | 12.4 | 1.0 | 10.0 |
| 4180 | 4.9 | 2.4 | 8.0 | 1.0 | 7.8 | 17.6 | 0.8 | 15.5 |
| 4182 | 7.3 | 1.8 | 8.7 | 3.0 | 8.1 | 15.8 | 1.2 | 10.6 |
| 4191 | 11.6 | 2.2 | 17.5 | 8.3 | 15.3 | 38.6 | 5.2 | 25.7 |
| 4194 | 8.2 | 2.1 | 12.4 | 5.2 | 9.1 | 19.2 | 1.5 | 12.1 |
| 4196 | 18.2 | 4.5 | 20.6 | 8.3 | 27.1 | 66.4 | 10.5 | 55.2 |
| Average | 8.3 | 1.59 | 11.8 | 4.71 | 10.4 | 23.41 | 3.1 | 17.67 |
| Av. 1940 | 7.1 | - | 15.6 | - | 12.2 | - | - | - |

## Table 6
## Color and Turbidity
## Steffen

| Sample Number | Sugar Solution | | | | Barley Candy Solution | | | |
|---|---|---|---|---|---|---|---|---|
| | Color | | Turbidity | | Color | | Turbidity | |
| | B-K Index | Filt. N-W $(-\log t)10^3$ | B-K Index | Filt. N-W $(-\log t)10^3$ | B-K Index | Filt. N-W $(-\log t)$ $10^3$ | B-K Index | Filt. N-W $(-\log t)10^3$ |
| 4101 | 11.6 | 2.1 | 14.0 | 5.1 | 12.0 | 21.2 | 2.2 | 18.8 |
| 4102 | 6.7 | 0.6 | 5.2 | 2.0 | 6.4 | 12.4 | 1.0 | 8.5 |
| 4104 | 9.1 | 2.0 | 8.2 | 3.6 | 15.0 | 37.3 | 4.3 | 25.1 |
| 4107 | 7.8 | 2.1 | 7.3 | 0.6 | 7.9 | 15.2 | 1.5 | 7.2 |
| 4109 | 14.1 | 3.5 | 14.3 | 6.6 | 13.3 | 30.0 | 3.7 | 17.9 |
| 4113 | 13.1 | 3.3 | 11.8 | 4.6 | 14.5 | 32.1 | 2.8 | 17.6 |
| 4119 | 13.1 | 2.9 | 12.8 | 5.0 | 14.8 | 33.7 | 3.6 | 19.7 |
| 4120 | 8.3 | 1.5 | 14.7 | 5.6 | 8.6 | 20.4 | 1.7 | 17.6 |
| 4124 | 5.7 | 0.9 | 10.0 | 3.3 | 8.4 | 17.6 | 0.9 | 12.7 |
| 4126 | 6.6 | 0.6 | 5.6 | 3.6 | 9.9 | 17.9 | 2.6 | 14.0 |
| 4127 | 13.2 | 3.4 | 11.6 | 4.2 | 18.4 | 53.9 | 5.3 | 21.9 |
| 4128(a) | 10.0 | 1.7 | 10.5 | 3.6 | 12.6 | 28.3 | 0.8 | 13.3 |
| (b) | 10.4 | 2.1 | 8.2 | 4.3 | 12.3 | 31.5 | 2.3 | 14.8 |
| 4129 | 10.0 | 1.1 | 5.0 | 3.9 | 8.7 | 16.4 | 1.5 | 9.4 |
| 4130 | 7.2 | 1.5 | 5.9 | 1.8 | 8.7 | 17.3 | 2.7 | 13.6 |
| 4131 | 9.0 | 1.0 | 8.6 | 4.4 | 10.9 | 22.9 | 2.2 | 17.3 |
| 4137 | 6.3 | 0.6 | 5.7 | 1.7 | 14.8 | 36.3 | 2.2 | 16.1 |
| 4140 | 25.0 | 2.2 | 38.2 | 16.4 | 15.6 | 21.9 | 14.3 | 60.7 |
| 4141 | 8,3 | 1.4 | 6.9 | 2.8 | 10.1 | 21.7 | 3.5 | 12.7 |
| 4142 | 5.7 | 1.1 | 4.9 | 2.8 | 7.6 | 17.6 | 2.4 | 14.0 |
| 4146 | 11.1 | 0.9 | 14.0 | 5.9 | 12.2 | 25.5 | 4.2 | 19.8 |
| 4153 | 9.3 | 1.3 | 11.6 | 3.7 | 7.8 | 15.7 | 2.8 | 64.6 |
| 4155 | 10.7 | 2.0 | 10.4 | 4.9 | 11.7 | 26.0 | 4.6 | 20.7 |
| 4156(a) | 5,1 | 0.9 | 8.7 | 3.5 | 5.7 | 18.2 | 0.6 | 7.0 |
| (b) | 6,8 | 1.0 | 4.3 | 1.2 | 6.7 | 20.1 | 1.7 | 11.5 |
| 4157 | 9.4 | 1.3 | 8.2 | 4.2 | 10.1 | 19.1 | 1.1 | 16.7 |
| 4158 | 17.3 | 2.5 | 7.6 | 3.7 | 11.4 | 24.1 | 2.6 | 16.7 |
| 4160 | 7.6 | 1.2 | 8.8 | 2.9 | 9.7 | 26.4 | 0.5 | 10.9 |
| 4162 | 13.7 | 3.5 | 12.3 | 4.1 | 11.8 | 26.3 | 2.5 | 13.3 |
| 4163 | 12.8 | 4.0 | 8.5 | 3.0 | 14.3 | 29.2 | 1.3 | 16.0 |
| 4164(a) | 12.1 | 3.0 | 13.0 | 3.8 | 6.8 | 16.7 | 1.0 | 9.4 |
| (b) | 7.9 | 0.6 | 5.9 | 3.0 | 7.5 | 7.6 | 1.5 | 7.6 |
| 4165 | 7.3 | 0.2 | 8.5 | 4.2 | 13.8 | 31.0 | 1.8 | 17.9 |
| 4168 | 8.9 | 1.6 | 14.1 | 6.5 | 16.8 | 44.0 | 3.6 | 21.0 |
| 4171 | 10.8 | 2.9 | 7.6 | 2.2 | 8.9 | 14.8 | 0.7 | 12.4 |
| 4172 | 4.4 | 0.3 | 3.3 | 0.9 | 7.0 | 14.3 | 0.8 | 10.3 |
| 4175 | 10.5 | 0.2 | 18.3 | 9.6 | 11.8 | 26.2 | 3.2 | 18.8 |
| 4177 | 8.7 | 1.7 | 7.0 | 3.0 | 16.6 | 31.5 | 12.3 | 44.7 |
| 4178 | 9.6 | 1.6 | 11.3 | 3.6 | 10.8 | 21.6 | 0.8 | 10.9 |
| 4179 | 13.4 | 0.2 | 21.2 | 11.6 | 14.6 | 25.3 | 8.4 | 33.7 |
| 4183 | 10.1 | 2.0 | 9.4 | 3.0 | 5.5 | 17.9 | 0.8 | 7.3 |
| 4184 | 7.4 | 0.6 | 5.8 | 2.6 | 15.4 | 38.0 | 3.1 | 19.8 |
| 4190 | 4.2 | 0.0 | 4.2 | 1.9 | 7.5 | 16.7 | 0.0 | 3.4 |
| 4195 | 13.8 | 3.3 | 16.3 | 7.6 | 11.3 | 20.4 | 2.4 | 17.9 |
| Average | 9.7 | 1.65 | 10.4 | 4.26 | 11.2 | 23.66 | 2.9 | 18.50 |
| Av. 1940 | 8.5 | - | 15.0 | - | 12.7 | - | - | - |

### Table 7
### Reflectance, Foaming etc.
### Non-Steffen

| Sample Number | Reflectance Whole Sugar | Reflectance 30-40 Frac. | Reflectance 40-50 Frac. | Screening Summary on 30 | Screening Summary 30 40 | Screening Summary 40 50 | Screening Summary past 50 | Foaming Test Maximum Old | Foaming Test Maximum New | Foaming Test Final Avg. | Nitrogen (amino) p.p.m. | Candy test reducing sugars |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4103 | 92.5 | 89.9 | 91.6 | 0% | 13% | 49% | 38% | 100 | 115 | 80 | 11.8 | 1.42% |
| 4105 | 91.7 | 90.3 | 91.5 | 1 | 37 | 31 | 31 | 100 | 115 | 78 | 9.6 | 1.83 |
| 4106(a) | 94.3 | - | 92.2 | 0 | 4 | 32 | 64 | 90 | 130 | 83 | 12.3 | 1.18 |
| (b) | 90.4 | 89.3 | 90.8 | 25 | 50 | 17 | 8 | 105 | 130 | 83 | — | 1.10 |
| 4108 | 92.0 | 91.2 | 92.1 | 0 | 21 | 38 | 41 | 90 | 115 | 78 | 13.4 | 1.83 |
| 4110 | 91.2 | 90.2 | 92.1 | 0 | 22 | 46 | 32 | 100 | 125 | 83 | 5.2 | 1.46 |
| 4111 | 91.4 | 89.8 | 90.6 | 0 | 48 | 33 | 19 | 95 | 115 | 85 | 13.4 | 1.67 |
| 4112 | 92.3 | 90.6 | 92.0 | 0 | 9 | 56 | 35 | 95 | 105 | 80 | 13.4 | 2.06 |
| 4114 | 92.4 | 90.5 | 92.7 | 0 | 11 | 53 | 36 | 85 | 100 | 73 | 5.3 | 2.22 |
| 4115 | 93.3 | 89.8 | 91.8 | 0 | 16 | 46 | 38 | 95 | 135 | 85 | 12.3 | 1.40 |
| 4116 | 91.6 | 90.2 | 91.5 | 0 | 24 | 39 | 37 | 120 | 130 | 80 | 8.6 | 2.11 |
| 4117 | 91.6 | 90.0 | 91.4 | 2 | 31 | 45 | 22 | 85 | 100 | 75 | 9.6 | 1.43 |
| 4118 | 89.5 | 88.7 | 90.2 | 3 | 43 | 30 | 24 | 85 | 95 | 78 | 15.0 | 1.80 |
| 4121 | 91.6 | — | 90.8 | 0 | 8 | 54 | 38 | 90 | 105 | 85 | 5.3 | 1.29 |
| 4122 | 92.7 | 90.0 | 91.8 | 1 | 14 | 39 | 46 | 95 | 130 | 83 | 12.3 | 1.28 |
| 4123 | 93.0 | 90.2 | 91.8 | 0 | 9 | 47 | 44 | 85 | 115 | 78 | 10.7 | 1.45 |
| 4125 | 92.8 | 90.2 | 92.0 | 0 | 18 | 49 | 33 | 120 | 125 | 88 | 10.7 | 1.32 |
| 4132 | 91.7 | 90.4 | 91.5 | 1 | 34 | 38 | 27 | 90 | 100 | 80 | 12.3 | 2.24 |
| 4133 | 89.7 | 86.0 | 88.6 | 1 | 37 | 40 | 22 | 105 | 150 | 110 | 18.7 | 1.19 |
| 4134 | 91.6 | 88.6 | 91.2 | 0 | 26 | 45 | 29 | 85 | 100 | 80 | 15.0 | 1.34 |
| 4135 | 92.0 | 89.4 | 91.4 | 0 | 17 | 50 | 33 | 125 | 155 | 93 | 7.5 | 2.09 |
| 4136 | 92.6 | 89.4 | 91.4 | 3 | 24 | 36 | 37 | 100 | 115 | 83 | 15.0 | 1.26 |
| 4138 | 89.3 | 87.2 | 88.0 | 1 | 32 | 46 | 21 | 95 | 105 | 83 | 19.8 | 2.17 |
| 4139 | 92.3 | 88.9 | 91.3 | 0 | 22 | 46 | 32 | 100 | 120 | 88 | 12.5 | 1.26 |
| 4143(a) | 92.0 | — | — | - | - | - | - | 100 | 125 | 85 | 13.4 | 1.33 |
| (b) | 91.6 | 89.3 | 91.3 | 0 | 25 | 47 | 28 | 100 | 110 | 80 | — | 1.28 |
| 4144(a) | 90.3 | 88.9 | 89.9 | 2 | 41 | 38 | 19 | 100 | 120 | 80 | 5.3 | 1.43 |
| (b) | 91.7 | 89.4 | 90.6 | 0 | 23 | 50 | 27 | 95 | 110 | 80 | 5.3 | 1.44 |
| 4145(a) | 91.5 | 89.3 | 90.5 | 1 | 28 | 35 | 36 | 90 | 110 | 80 | 10.7 | 2.09 |
| (b) | 89.7 | 89.2 | 90.9 | 14 | 55 | 19 | 12 | 115 | 140 | 80 | — | 1.23 |
| 4147 | 91.0 | 88.5 | 90.2 | 1 | 25 | 40 | 36 | 100 | 140 | 95 | 25.2 | 1.13 |
| 4149 | 92.4 | 90.1 | 91.8 | 0 | 22 | 50 | 28 | 85 | 100 | 68 | 10.7 | 1.37 |
| 4150 | 92.6 | 89.7 | 91.6 | 0 | 24 | 45 | 31 | 90 | 115 | 80 | 12.8 | 1.29 |
| 4151 | 89.0 | 87.4 | 89.0 | 2 | 31 | 45 | 22 | 90 | 135 | 95 | 23.0 | 1.35 |
| 4152 | 91.2 | 87.8 | 89.9 | 0 | 11 | 45 | 44 | 85 | 105 | 83 | 16.1 | 1.43 |
| 4159 | 92.5 | 90.2 | 92.3 | 2 | 32 | 36 | 30 | 110 | 125 | 83 | 8.0 | 1.62 |
| 4161 | 91.7 | — | — | - | - | - | - | 90 | 100 | 80 | 10.7 | 1.52 |
| 4166 | 91.6 | 88.8 | 90.8 | 2 | 24 | 36 | 38 | 90 | 130 | 88 | 12.8 | 1.31 |
| 4167 | 92.9 | 91.2 | 92.3 | 1 | 21 | 49 | 29 | 95 | 105 | 78 | 16.1 | 1.45 |
| 4169 | 92.5 | 89.3 | 91.7 | 0 | 18 | 40 | 42 | 120 | 130 | 88 | 11.8 | 1.85 |
| 4173 | 92.0 | 87.7 | 90.5 | 0 | 10 | 36 | 54 | 95 | 120 | 83 | 16.1 | 1.26 |
| 4176 | 92.0 | 90.4 | 91.2 | 0 | 19 | 56 | 25 | 90 | 100 | 78 | 7.5 | 2.66 |
| 4180 | 92.0 | 90.7 | 91.7 | 0 | 25 | 44 | 31 | 100 | 110 | 80 | 8.0 | 1.34 |
| 4182 | 92.0 | 90.5 | 91.8 | 0 | 20 | 44 | 35 | 90 | 120 | 80 | 12.8 | 1.47 |
| 4191 | 87.4 | 88.2 | 89.3 | 57 | 29 | 11 | 13 | 100 | 120 | 83 | 15.0 | 1.17 |
| 4194 | 90.8 | 88.0 | 90.3 | 5 | 42 | 35 | 17 | 95 | 115 | 83 | 5.3 | 1.12 |
| 4196 | 86.0 | 86.2 | 87.3 | 37 | 40 | 18 | 5 | 90 | 100 | 78 | 20.3 | 1.42 |
| Average | 91.8 | 89.6 | 91.2 | 0.5 | 23 | 43 | 33.5 | 96 | 117 | 83 | 12.1 | 1.58 |
| Av.1940 | 92.8 | - | - | 1.5 | 32.5 | 38 | 28 | 94 | - | 82 | - | 2.57 |

## Reflectance, Foaming etc.
## Steffen

| Sample | Reflectance | | | Screening | Summary | | | Foaming | Test | | Nitrogen | Candy test |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Whole Sugar | 30-40 Frac. | 40-50 Frac. | on 30 | 30-40 | 40-50 | past 50 | Maximum Old | Maximum New | Final Avg. | (amino) p.p.m. | reducing sugars |
| 4101 | 91.2 | 89.1 | 90.7 | 4% | 35% | 36% | 25% | 85 | 100 | 80 | 15.0 | 1.70% |
| 4102 | 92.2 | 89.5 | 91.1 | 0 | 28 | 41 | 31 | 90 | 105 | 78 | 9.6 | 1.31 |
| 4104 | 91.7 | 89.3 | 90.8 | 3 | 30 | 36 | 31 | 90 | 120 | 85 | 19.8 | 1.05 |
| 4107 | 92.1 | 90.6 | 91.8 | 0 | 16 | 46 | 38 | 85 | 110 | 75 | 15.0 | 1.37 |
| 4109 | 91.2 | 88.4 | 89.9 | 0 | 15 | 45 | 40 | 80 | 100 | 85 | 18.7 | 1.35 |
| 4113 | 91.3 | 88.0 | 89.8 | 1 | 24 | 44 | 31 | 80 | 100 | 80 | 18.7 | 1.65 |
| 4119 | 90.6 | 89.2 | 90.5 | 1 | 22 | 44 | 33 | 95 | 120 | 88 | 13.4 | 1.64 |
| 4120 | 91.2 | 89.1 | 90.4 | 0 | 16 | 44 | 40 | 95 | 105 | 88 | 13.4 | 1.26 |
| 4124 | 92.5 | 90.8 | 91.8 | 17 | 49 | 14 | 20 | 85 | 115 | 88 | 9.1 | 1.36 |
| 4126 | 91.8 | 90.4 | 92.1 | 1 | 36 | 41 | 22 | 90 | 115 | 85 | 8.0 | 2.15 |
| 4127 | 90.2 | 88.4 | 89.6 | 2 | 38 | 37 | 23 | 95 | 115 | 88 | 25.2 | 1.13 |
| 4128(a) | 91.6 | 89.8 | 90.8 | 2 | 29 | 46 | 23 | 100 | 115 | 88 | 11.8 | 1.48 |
| (b) | 91.8 | - | - | - | - | - | - | 100 | 125 | 90 | — | 1.28 |
| 4129 | 92.1 | 90.3 | 92.0 | 0 | 16 | 46 | 38 | 90 | 120 | 90 | 7.0 | 1.76 |
| 4130 | 92.8 | 90.2 | 92.0 | 2 | 28 | 37 | 33 | 105 | 150 | 85 | 8.0 | 1.38 |
| 4131 | 92.1 | — | 90.4 | 0 | 6 | 42 | 52 | 85 | 105 | 80 | 13.4 | 1.90 |
| 4137 | 92.8 | 91.4 | 92.4 | 0 | 16 | 46 | 38 | 95 | 120 | 88 | 13.4 | 1.88 |
| 4140 | 92.2 | 89.0 | 91.2 | 0 | 15 | 48 | 37 | 90 | 100 | 80 | 7.0 | 1.46 |
| 4141 | 91.5 | 90.2 | 91.1 | 0 | 12 | 53 | 35 | 85 | 105 | 83 | 12.8 | 1.65 |
| 4142 | 93.3 | 90.1 | 91.8 | 0 | 18 | 45 | 37 | 100 | 140 | 88 | 13.4 | 1.20 |
| 4146 | 91.8 | 90.2 | 91.3 | 2 | 32 | 36 | 30 | 110 | 125 | 83 | 12.3 | 1.62 |
| 4153 | 93.2 | 91.4 | 92.6 | 1 | 9 | 59 | 31 | 90 | 95 | 78 | 9.6 | 1.49 |
| 4155 | 91.5 | 89.7 | 90.7 | 2 | 32 | 44 | 22 | 85 | 100 | 73 | 21.4 | 1.39 |
| 4156(a) | 91.2 | 89.8 | 91.4 | 2 | 48 | 35 | 15 | 100 | 105 | 80 | 7.5 | 1.46 |
| (b) | 93.1 | 91.5 | 92.4 | 0 | 26 | 49 | 25 | 100 | 120 | 85 | 10.7 | 1.38 |
| 4157 | 92.2 | 89.0 | 91.5 | 1 | 12 | 53 | 34 | 85 | 100 | 80 | 12.8 | 1.53 |
| 4158 | 90.2 | 88.5 | 90.5 | 3 | 47 | 36 | 14 | 100 | 110 | 90 | 15.1 | 1.38 |
| 4160 | 92.1 | 89.9 | 91.8 | 1 | 19 | 51 | 29 | 100 | 115 | 80 | 13.4 | 1.39 |
| 4162 | 90.8 | 88.7 | 90.2 | 0 | 14 | 51 | 35 | 85 | 105 | 80 | 10.7 | 1.37 |
| 4163 | 91.6 | 89.4 | 90.1 | 1 | 29 | 43 | 27 | 85 | 95 | 80 | 9.6 | 1.34 |
| 4164(a) | 90.5 | 88.7 | 90.7 | 0 | 38 | 39 | 23 | 100 | 115 | 85 | 12.3 | 1.28 |
| (b) | 92.7 | 89.7 | 91.7 | 0 | 21 | 43 | 36 | 90 | 100 | 83 | 13.4 | 2.34 |
| 4165 | 91.4 | 89.3 | 90.2 | 1 | 31 | 40 | 28 | 120 | 140 | 88 | 16.1 | 1.90 |
| 4168 | 93.4 | 89.0 | 90.1 | 0 | 8 | 37 | 55 | 125 | 135 | 80 | 14.5 | 1.58 |
| 4171 | 91.7 | 89.6 | 91.5 | 0 | 22 | 51 | 27 | 100 | 130 | 93 | 12.8 | 1.35 |
| 4172 | 93.2 | — | 92.8 | 0 | 7 | 48 | 45 | 100 | 120 | 98 | 9.1 | 1.47 |
| 4175 | 90.4 | 88.6 | 90.2 | 1 | 26 | 43 | 30 | 95 | 105 | 85 | 13.9 | 1.79 |
| 4177 | 91.8 | 90.8 | 91.7 | 0 | 26 | 48 | 26 | 95 | 110 | 85 | 10.7 | 1.74 |
| 4178 | 91.8 | 89.4 | 90.6 | 0 | 28 | 43 | 29 | 90 | 100 | 81 | 10.7 | 1.40 |
| 4179 | 93.0 | — | 92.2 | 0 | 5 | 47 | 48 | 85 | 100 | 83 | 14.5 | 2.10 |
| 4183 | 90.7 | 89.4 | 90.1 | 0 | 31 | 51 | 18 | 120 | 160 | 100 | 10.7 | 1.28 |
| 4184 | 91.3 | 90.3 | 91.7 | 0 | 42 | 35 | 23 | 115 | 130 | 100 | 14.5 | 1.77 |
| 4190 | 94.1 | 91.5 | 92.4 | 2 | 15 | 46 | 37 | 90 | 95 | 78 | 6.2 | 1.40 |
| 4195 | 88.2 | 86.7 | 88.6 | 5 | 40 | 38 | 17 | 100 | 125 | 100 | 13.9 | 1.24 |
| Average | 91.8 | 89.7 | 91.1 | 1 | 24 | 43 | 32 | 95 | 114 | 85 | 13.0 | 1.54 |
| Av. 1940 | 93.0 | — | — | 1 | 28 | 41 | 30 | 95 | — | 83 | — | 2.62 |

numbers. The actual specific conductivities are given in table 5; the factors will be considered only as average values and are given in table 10. As the specific conductivity for the 30-gram concentration commonly used, it is satisfactory to use the factors given without adopting the higher concentration used in this work. It is recommended that in geographical area No, 3 the factor used be about 375, in areas Nos. 2 and 4 about 394, and in area No. 1 about 407. This adjustment of the factors will give a better approximation of the carbonate ash from specific conductivity. These factors are the averages of three years work, with much care being used in the determinations of the carbonate ash, which is the test that is most difficult to duplicate.

## 2. Sulphites

The sulphites again show a low average value, the same as in 1940. Only two sugars gave values of over 20 p.p.m. of $SO_2$ and 61 had sulphites of less than 10 p.p.m. The sulphur used averaged 0.35 lbs per ton of beets for those sugars of less than 10 p.p.m. of $SO_2$, 0.50 lbs for the 10 to 20 p.p.m. and 0.68 lbs for over 20 p.p.m. This statement should not be interpreted to mean that the quanitity of sulphur used is the only factor determining the sulphite content of the sugars. There are evidently other factors, for in individual cases the sulphites were low in spite of heavy use of sulphuring and in others relatively high in spite of moderate use of sulphuring. The lower average for sulphites in Steffen sugars may be in part due to the lower average amount of sulphur used.

## 3. Sulphates

The average sulphate content is essentially unchanged. The data on the 1940 samples was recalculated, correcting for a systematic error which made the results as reported too high. For contrast, again referring to the 1936 report it is noted that in that year some 27% of the sugars contained 20 or more p.p.m. of $SO_3$ and 37% were below 10 p.p.m. This year only 3% of the sugars were over 20 p.p.m. and 75% were below 10 p.p.m.

## 4. Chlorides

The chloride content showed a decrease below 1940, on the average. Some 65% of the sugars had only 5 p.p.m. of Cl or less. This is one factor which has shown little change since 1936 when the average was much the same and the proportion of sugars of 5 p.p.m. or below was also the same.

## 5. Lime (CaO)

The CaO content as determined is slightly higher than in 1940 but still low as compared with earlier years. The relationship between lime salts in first liquor and CaO in sugar is not uniform but the natural trend is evident. Where lime salts were below 0.030 the average CaO on the corresponding sugars was 4 p.p.m. for 0.030 to 0.060 lime salts the average CaO on sugar was 6 p.p.m. and with lime salts above 0.060 the CaO was near 8 p.p.m.

## 6. Silica

The silica determination, being made gravimetrically on the hydrochloric acid solution of the ash, includes all insolubles present under this condition. The values are exceptionally high on a few sugars but on the average are lower than last year. Double filtration of standard liquor may be reducing the silica content. The sugars of the factories using double filtration averaged 3 p.p.m. silica and the other sugars averaged 6 p.p.m.

## 7. Combined Organic Acids and Estimated Salts

The ash alkalinity was estimated through the determination of $SO_3$ on sulphated ash, correcting same for the original $SO_2$, $SO_3$ and Cl. The combined organic acid was calculated from the corrected ash alkalinity arbitrarily assuming a combining weight of 80 for the organic radical. The 1940 data was recalculated on this same basis making them somewhat different from the values reported. A slight decrease is noted when compared with the 1940 results, which is to be expected from the lower ash. In general, the present data confirms the observations made last year. High ash is most often correlated with high organic acids rather than high inorganic acids.

Total, inorganic and organic salts are calculated with potash as the base. The contrast in the salt content for a particular carbonate ash value is often quite striking where the one sugar is especially low in sulphites, sulphates and chloride and high in organic acid radicals. For example, two sugars of 0.0076% and 0.0077% ash, respectively, show 0.0133% and 0.0102% total salts. Carbonate ash is not a satisfactory basis for judging sugar purity and it is felt that the calculated total salts does give a fairer comparison. The contrasts in the distribution of total salts between inorganic and organic combinations in sugars from different sources is very great and will be discussed further later in the report.

## 8. pH of Sugar Solutions

The pH of sugar solutions were measured electrometrically at a concentration of 30 grams of sugar per 100 cc. While there is not a uniform relationship between the pH of white massecuite and pH of the white sugar, yet it may be noted that the non-Steffan white massecuites average higher in pH than the Steffen massecuites and the same trend is observed in the corresponding white sugars. Another correlation is also suggested, for taking the sugars of high organic salt content it may be noted that the majority are relatively high in pH. This is most evident in the non-Steffen sugars. Sugars whose organic salt content as percent of total salts is below 50% average a pH of 6.65, while the group with proportions of organic salts above 50% average a pH of 6.92. Viewed slightly differently, of the sugars with organic salts below 50% of the total salts, there are none with pH of 7.0 or above, while of the sugars with higher proportions of organic salts nearly 60% are above 7.0 pH. Such a relationship might be assumed on the basis of the higher alkalinity of organic salts as compared with inorganic salts. The contrast in pH between non-Steffen and Steffen sugars is contrary to this observation for the Steffen sugars show higher proportions of organic salts yet have a lower average pH. Taken separately, however, the Steffen sugars show this same trend that was just discussed.

### 9. Color and Turbidity of Sugar Solutions

That the type and intensity of the turbidity in the solutions of some sugars greatly affects the color units as found by the B-K method, has been observed ever since this method was adopted. With moderate turbidities of the common type the B-K color units seem reasonably accurate. It seems desirable to put the color of all the sugars, irrespective of the type or intensity of the turbidity, on the same basis by the adoption of a filtration method. This year all sugar solutions were read both by the B-K instrument as described in 1936 and also after filtercel filtration. The filtration used consisted in filtering with about 2% of standard filtercel through a precoated disc of filter paper in a very small Buchner funnel. A vacuum distillation receiver was used so that the first half of the filtrate could be discarded and the subsequent filtrate collected separately without having to break the vacuum. Use of such a filtration method makes an arbitrary separation between color and turbidity which is decidedly superior to the B-K method when excessive turbidity is present. For the color and turbidity measurements an abridged photoelectric spectrophotometer was used which required a smaller volume of filtrate than the B-K instrument. The percent transmission was calculated to - log t and expressed as whole numbers. In general the B-K turbidity varied in direct correlation with the turbidity read on the new instrument, the corresponding - log t of the B-K measurement averaging about 25% higher than on the N-W instrument. This designation "N-W" in the tables and text refers to measurements with the new instrument.

With equal turbidity the two instruments and methods for comparing color agreed but with varied turbidity the color values shown by the B-K reading are not related to the filtered color. The following examples may make clear the effect of turbidity on the color readings made by the B-K method. First are two examples where the turbidity of two sugar solutions is very similar and then two examples where the turbidities are very different.

| Sugar | Turbidity | | | Color | | |
|---|---|---|---|---|---|---|
| | N-W | B-K | | N-W | B-K | |
| | -log t | Index | -log t | -log t | Index | -log t |
| A | 8.9 | 21.3 | 11.5 | 5.4 | 20.0 | 10.8 |
| B | 8.3 | 20.6 | 11.1 | 4.5 | 18.2 | 9.7 |
| C | 1.6 | 5.4 | 2.7 | 0.6 | 3.0 | 1.5 |
| D | 2.9 | 6.4 | 3.2 | 0.4 | 3.0 | 1.5 |
| E | 14.2 | 27.4 | 15.2 | 0.2 | 13.7 | 7.1 |
| F | 1.5 | 5.5 | 2.7 | 0.2 | 4.8 | 2.4 |
| G | 15.0 | 33.0 | 19.3 | 2.5 | 12.5 | 6.2 |
| H | 3.0 | 7.2 | 3.6 | 2.5 | 8.8 | 4.4 |

In the A-B and the C-D comparisons with the turbidity rather uniform the sugar solution colors by the B-K and the filtration methods agree closely in their relative values both where the color was high, as in A-B, and where it was low, as in C-D. In the other examples, high turbidities are contrasted with low turbidities The E-F comparison is the best example of the abnormally high color readings obtained by the B-K method due to high turbidity of the milky type. That the E sample was really essentially colorless, as indicated by the filtered color, is evident in the visual appearance of the sugar solution and by the normally high reflectance of the dry sugar. In the example G-H the turbidity was not of the milky type but was high and had some, if lesser, effect in exaggerating the B-K color index. It is not claimed that the filtration method is perfect but in comparing such a wide variety of sugars as handled in these studies it is felt that it decidedly gives truer comparative color values for the sugar solutions.

The color of sugar like all other criteria of sugar quality, is dependent on so many operating factors, as well as original quality of the beets, that it is found to be impossible to establish correlations with individual factors. White pan purities show some relationship to sugar color but not as satisfactory as in the case of ash content. It is quite probable that in some cases the benefits of high purity massecuite are lost by poorer work in sugar boiling or at the centrifugal station. And conversely a relatively lower pan purity may be compensated for by extra care in these later operations.

On the basis of the B-K values for color there appears to be an increase in the average sugar color this year and as there was a decrease in the average turbidity it is probable that this increase was real and may be greater than shown by B-K values. Steffen sugars average slightly higher in color than non-Steffen by both methods of color estimation and in spite of the usual lower turbidity of Steffen sugars.

## 10. Color and Turbidity of Barley Candies

As in the case of the sugars, the color and turbidity of the candies were estimated by both the B-K method and by the filtration method. As the B-K indexes are not adjusted for the greater dilution of the candy solutions, as compared with the sugars, the contrast between the two methods is considerably different. However if the B-K values are calculated to the -log t basis the comparisons lead to much the same conclusions regarding the methods as pointed out under the discussion of color in the sugars. High turbidities exaggerate the B-K color index to the extent that they are very misleading. The agreement on turbidity is again reasonably good, but there appears to be some distortion of B-K turbidities by high colors. On the -log t basis the turbidities by both methods are much greater than found in the sugars. This is not evident in the B-K index as reported. From the study of the data it is believed that the filtration method gives a more uniform basis of comparing color and turbidity of the candy solutions and that the results agree more closely with visual observations.

Unlike the sugar colors, the candy colors on the B-K index basis showed a decrease in color when compared with last years results. This is in line with the theory that one of the primary factors influencing candy color is the ash content, which was lower this year. However, neither ash nor any other individual factor seems to correlate very exactly with candy color; only by averaging large numbers of sugars are definite trends evident.

## 11. Reflectance

Reflectance is given not only for the whole sugar as supplied but also for two screened fractions; the one consisted of sugar passing screen no.30 and retained on no.40 and the other was the sugar passing no.40 and retained on no.50. The reflectance on the whole sugars show an average decrease below last year. This is in line with the higher average B-K sugar solution color. The results on the screened fractions indicate, as would be expected, that some high reflectances are due to larger proportions of fine grain. To illustrate this, examples are given as follows:

| Sugar | Reflectance<br>Whole Sugar | Reflectance<br>30-40 Frac. | Sugar passing no.50 screen |
|---|---|---|---|
| A | 92.7 | 90.0 | 46% |
| B | 91.6 | 90.0 | 22% |
| C | 92.0 | 87.7 | 54% |
| D | 92.0 | 90.4 | 25% |

In example A-B two sugars of differing whole sugar reflectance are seen to be equal in respect to the reflectance on the screened fraction. The high reflectance of the A whole sugar being due to a larger proportion of fine grain. In example C-D sugars of equal whole sugar reflectance are seen to have a differing reflectance on the uniform grain size basis. For commercial purposes it is certain that the reflectance of the whole sugar is all important but in trying to compare the sugars on a scientific basis it is of interest to put all the sugars on the uniform basis of the reflectance of a screened fraction. When this is done a very fair correlation is found between sugar color in solution (filtered test) and the reflectance. The average reflectance of the 40-50 fraction corresponding to sugar solution colors in certain ranges are as follows:

| Sugar Solution Color N-W)-log t)$10^3$ | Average Reflectance of 40-50 Fraction | |
|---|---|---|
| | Non-Steffen | Steffen |
| below 1.0 | 91.7 | 91.7 |
| 1.0 to 2.0 | 91.4 | 91.3 |
| 2.0 to 3.0 | 90.7 | 90.8 |
| above 3.0(avg 4.6) | 88.9 | (avg.3.5)89.9 |

The reflectance on whole sugar is thus the result of at least these two factors, grain size and actual color of the sugar. When grain size is small and sugar color low extra high reflectances are obtained and visa versa.

Further studies of reflectance were made using a blue screen instead of white light. (The blue screen was the regular one used with the B-K insturment in solution color measurements.) The use of the blue screen often puts the sugars in a different order from that obtained with white light. In some studies made last year in cooperation with C. Lindfors (Michigan Sugar Co.) it appeared that the grading done with the blue screen agreed more closely with visual grading than did the values obtained with white light. While no visual grading was done this year, the examination of the data obtained did not indicate any significant differences in the order of the reflectances of the sugars when the blue screen was used. The drop in reflectance was fairly uniform and in the exceptional cases, where extremely large or small differences were found between readings with white light versus blue light, no reasonable or uniform cause for it could be found in the screening test nor sugar solution color.

## 12. Foaming Test

In studies of the foaming test made by A. R. Nees (Great Western Sugar Co.), it was found that if the sugar mixture were stirred during the heating a higher foaming test was obtained; the increase above the old method of testing was variable and appears to be a better differentiation between the foaming qualities of different sugars. In table 7 are given the points of maximum foaming by both the old and the new method, and the final foaming given is the average of the two tests, for the agreement was generally close in this regard. The only change made in the technique of conducting this test was in the matter of stirring until near the boiling point. This eliminates the variations observed in the usual test due to varying intervals between the time the water was put on the sugar and the time the test was actually started. Tests made by the old method often make sugars appear to have equivalent foaming characteristics which are really quite different. Note that the sugars giving a foaming point of 90 by the old test are scattered from 95 to 130 by the stirring method. As stirring is commonly used in commercial preparation of sugar solutions its adoption in making the foaming test is logical.

The average foaming test by the old method shows the same value this year as last in the case of the Steffen sugars and a slight increase in the non-Steffen. The foaming test has not been successfully correlated with any other factor determined.

## 13. Nitrogen

The nitrogen values given in table 7 are not total nitrogen but essentially the amino nitrogen. The estimations were made using the copper nitrate colorimetric method using a photoelectric photometer for measuring the color. Alanine was used in making the standard curve as this was found to give values near the average of the eight compounds studied. Betaine is not included by this test as it does not react with the reagent.

## 14. Formula Ratings and Sugar Purities

The past method of establishing a formula rating has several faults. It is so susceptible to the B-K turbidity values that in cases where turbidity was extremely high a very low rating was obtained on sugars that had good reflectance and perhaps even low ash and sulphites. It has seemed desirable to include more factors in the formula rating and in such a way that the common variations in the unit quantities would be equal. In other words put all the factors on the same uniform basis insofar as they affect the final rating. Thus a value that was high by a particular amount would be exactly compensated for by some other factor that was low by this same particular amount. Further it is proposed to put the rating obtained on a proportional basis by assuming a standard sugar of a quality that can be produced and express its percentage relationship with the sugar tested. T

Tentatively seven factors will be included in this new formula rating, namely sulphated ash, $SO_2$, color(-log t), turbidity(-log t), color of candy(-log t), reflectance, and the new foaming test maximum. The standard sugar arbitrarily adopted is as follows:

| | | |
|---|---|---|
| Sulphated ash X $10^2$ | 0.8 | (80 p.p.m.) |
| Sulphites($SO_2$) $10^3$ | 0.5 | ( 5 p.p.m.) |
| Filtered Color Sugar | 0.2 | (-log t)$10^3$ |
| " " Candy | 1.0 | (-log t)$10^2$ |
| Turbidity of Sugar | 0.5 | 1/2(-log t)$10^3$ |
| Reflectance | 6.0 | (100 - 94 reflectance) |
| Foaming Maximum | 10.0 | (100/10) |
| Total | 20.0 | |

100-20 is 80, the rating of the standard sugar.

While the size of some of the units may appear large as compared with others, it is established that the variation in each of these units is roughly the same amount. For example, a foaming maximum of 11.0 will be compensated by a reflectance of 5.0 (100-95). With this rating of 80 for the standard sugar, the rating of a test sugar is divided thereby to obtain the proportional value by which it is related to this standard. In Table 8 is shown the old type formula ratings and the new percentage ratings. It should be kept in mind that these percentage ratings are not just the old formula on a percentage basis, but are derived from a very different balancing of the various factors involved.

The old formula ratings are given primarily for comparison with last years values. In this connection, it will be noted that the ratings are higher this year than last. The proposed percentage rating is on just as arbitrary a basis as

Table 8

Formula Ratings and Sugar Purity

| Non-Steffen | | | | Steffen | | | |
|---|---|---|---|---|---|---|---|
| Sugar Number | Old Formula Rating | New Rating %age | Sugar Purity | Sugar Number | Old Formula Rating | New Rating %age | Sugar Purity |
| 4103 | 78.8 | 93.5 | 99.979 | 4101 | 65.9 | 91.5 | 99.971 |
| 4105 | 80.9 | 93.5 | .981 | 4102 | 81.7 | 97.4 | .980 |
| 4106(a) | 78.9 | 94.0 | .973 | 4104 | 67.5 | 86.9 | .957 |
| " (b) | 77.6 | 89.4 | .966 | 4107 | 77.2 | 94.5 | .975 |
| 4108 | 81.4 | 93.1 | .976 | 4109 | 61.4 | 87.3 | .966 |
| 4110 | 81.6 | 92.1 | .988 | 4113 | 65.3 | 88.5 | .964 |
| 4111 | 76.3 | 95.7 | .971 | 4119 | 62.0 | 84.9 | .967 |
| 4112 | 46.3 | 85.1 | .974 | 4120 | 68.8 | 90.7 | .975 |
| 4114 | 78.6 | 94.5 | .982 | 4124 | 72.7 | 92.6 | .977 |
| 4115 | 72.0 | 91.4 | .972 | 4126 | 78.6 | 92.9 | .978 |
| 4116 | 44.5 | 79.9 | .976 | 4127 | 56.1 | 81.0 | .945 |
| 4117 | 73.9 | 94.7 | .983 | 4128(a) | 62.8 | 88.9 | .963 |
| 4118 | 68.8 | 85.1 | .969 | " (b) | 59.2 | 85.2 | .951 |
| 4121 | 71.7 | 92.2 | .984 | 4129 | 74.7 | 91.9 | .978 |
| 4122 | 77.0 | 90.5 | .978 | 4130 | 76.1 | 89.6 | .978 |
| 4123 | 79.5 | 94.9 | .976 | 4131 | 69.4 | 91.9 | .969 |
| 4125 | 81.5 | 93.1 | .979 | 4137 | 76.9 | 91.7 | .970 |
| 4132 | 81.7 | 95.5 | .981 | 4140 | 22.3 | 82.9 | .972 |
| 4133 | 23.6 | 71.4 | .967 | 4141 | 73.5 | 92.2 | .970 |
| 4134 | 75.7 | 93.1 | .975 | 4142 | 80.6 | 91.4 | .975 |
| 4135 | 77.1 | 84.9 | .979 | 4146 | 66.1 | 89.0 | .973 |
| 4136 | 74.3 | 91.6 | .970 | 4153 | 72.4 | 97.2 | .982 |
| 4138 | 62.1 | 81.7 | .968 | 4155 | 67.7 | 90.4 | .964 |
| 4139 | 64.1 | 88.2 | .961 | 4156(a) | 79.1 | 93.1 | .985 |
| 4143(a) | 84.9 | 92.4 | .976 | " (b) | 80.8 | 94.6 | .980 |
| " (b) | 72.3 | 90.6 | .977 | 4157 | 73.5 | 94.1 | .975 |
| 4144(a) | 77.8 | 89.9 | .987 | 4158 | 66.5 | 88.9 | .970 |
| " (b) | 79.5 | 93.9 | .986 | 4160 | 68.4 | 90.4 | .967 |
| 4145(a) | 73.6 | 90.4 | .976 | 4162 | 65.0 | 88.1 | .975 |
| " (b) | 76.6 | 85.7 | .976 | 4163 | 67.6 | 90.1 | .982 |
| 4147 | 39.1 | 74.6 | .943 | 4164(a) | 69.3 | 89.1 | .979 |
| 4149 | 68.7 | 91.1 | .979 | " (b) | 83.5 | 99.1 | .983 |
| 4150 | 80.8 | 93.5 | .978 | 4165 | 75.0 | 87.6 | .971 |
| 4151 | 61.4 | 78.1 | .964 | 4168 | 62.8 | 84.7 | .964 |
| 4152 | 50.7 | 85.0 | .967 | 4171 | 74.7 | 90.1 | .976 |
| 4159 | 75.3 | 87.1 | .979 | 4172 | 81.5 | 95.6 | .977 |
| 4161 | 60.5 | 88.5 | .980 | 4175 | 58.7 | 87.8 | .970 |
| 4166 | 64.7 | 87.6 | .966 | 4177 | 74.8 | 91.1 | .976 |
| 4167 | 85.1 | 97.6 | .975 | 4178 | 70.9 | 93.4 | .978 |
| 4169 | 72.3 | 86.5 | .973 | 4179 | 54.0 | 90.7 | .968 |
| 4173 | 68.6 | 88.6 | .969 | 4183 | 73.6 | 85.1 | .979 |
| 4176 | 78.3 | 95.7 | .987 | 4184 | 75.5 | 87.6 | .968 |
| 4180 | 78.1 | 93.0 | .980 | 4190 | 84.9 | 101.0 | .981 |
| 4182 | 76.0 | 91.5 | .980 | 4195 | 57.9 | 80.5 | .969 |
| 4191 | 53.4 | 77.0 | .959 | | | | |
| 4194 | 70.1 | 88.6 | .980 | | | | |
| 4196 | 34.9 | 70.5 | .938 | | | | |
| Average | 70.5 | 89.7 | 99.975 | Average | 69.7 | 90.4 | 99.972 |
| Avg.1940 | 67.0 | -- | -- | Avg.1940 | 65.3 | -- | -- |

(Note- Results on 4106b,4143b,4144b,4145b, 4191,4194,4196,4128b,4156b,4190, and 4195 not included in the averages) the old formula rating but is different in that it includes more factors and these factors are rated on an equal basis.

The sugar purities included in table 8 are based on entirely different considerations. They were obtained as follows; 100 minus the sum of the total salts and the determined nitrogen calculated as glutamic acid. They are on the moisture free basis. They are probably slightly higher than the true chemical purity as there are other organic non-sugars which may be present. They are probably closer to the true purities than would be the values obtained by polarization. With normal moisture content the purities would be about 0.030% lower than the values given.

As might be expected white pan purities correlate rather well with the new percentage rating for the sugars and also with the purities of the sugars. The trend is very evident, as will be seen from the following table, in spite of the variations caused by the effect of the pan and centrifugal work.

| White Massecuite Purity | Above 93% | 91-93% | Below 91% |
|---|---|---|---|
| Average " " | 94.0 | 92.0 | 90.0 |
| Number of Sugars in group | 23 | 49 | 13 |
| Average %age Rating | 93.0 | 89.2 | 84.4 |
| Below 90 rating | 13% | 51% | 69% |
| Above 95 " | 22% | 0% | 15% |
| Average Sugar Purity | 99.977 | 99.973 | 99.967 |
| Below 99.975 purity | 22% | 47% | 77% |
| Above 99.980 | 26% | 14% | 0% |

These averages also indicate the general correlation between the new percentage rating and the estimated sugar purities. There are naturally exceptions in individual instances but the trend is definite. Apparently the sugar produced from a high quality massecuite is sometimes of poor quality because of the pan and centrifugal work and a low quality massecuite sometimes yields an excellent sugar because of special care and equipment. If a particular sugar does not have the quality that one would expect from the pan purity it is well to carefully consider the possibility of poor sugar boiling conditions and/or some weakness in the centrifugal work.

## 15. Screening Tests

The screening tests were made as in previous years. There is a distinct trend toward finer grained sugars, which is especially seen in the non-Steffen sugars. This change has been proceeding for years but is rather more pronounced than usual. The screening grade is roughly indicated by the letters in the final column of Table 9. "C" is coarse, "F" fine, "M" medium and "V" very. As in all other tables the averages only include the regular samples for the campaign.

## 16. Regional Averages

In the 1940 report, tables were given comparing the averages of the different sugars grouped for ten geographical areas. This year similar tables (No.10) group the sugars into the four major regions arbitrarily numbered from one to four. The non-Steffen and Steffen sugars are considered separately as in the previous tables. The primary object of these regional summaries is to give a basis on which the individual factory may compare their sugars with others from the same area rather than with the entire industry.

It may also be of interest to note that the sugars in area no. 1 are not high in ash because of high content of mineral salts but rather because of high amounts of organic salts. The sugars in this area are also highest in nitrogen compounds of the type determined. Because the ash is so largely due to organic salts, the acid radicals of which probably do not have the high specific conductivity of the mineral acids, the conductivity-ash factors are definitely higher than in the other areas.

## 17. Summary

In spite of the already high uniformity in quality of beet sugar, additional advance is to be seen in many respects and especially in the ash content. It is felt that the changes adopted in the measurement of color, turbidity and foaming will differentiate between sugars more accurately, and that the new percentage formula rating summarizes the various factors on a fairer basis. The use of proper conductivity-ash factors according to the area will give better estimations of ash from specific conductivities.

Table 9

Screening Tests
Non-Steffen

| Sample | Percent Retained on Screens U.S.No. | | | | | | | | Thru | On No. | Thru No.30 | Thru | Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | No.100 | 30 | On No.50 | No.80 | |
| 4103 | 0 | 0.2 | 12.4 | 48.8 | 10.8 | 10.0 | 7.2 | 5.8 | 4.8 | 0.2 | 61.2 | 10.6 | F |
| 4105 | 0 | 0.8 | 36.6 | 31.4 | 9.6 | 8.2 | 6.2 | 5.0 | 2.2 | 0.8 | 68.0 | 7.2 | MC |
| 4106(a) | 0 | 0 | 4.2 | 32.4 | 14.2 | 14.4 | 12.8 | 11.6 | 9.4 | 0 | 36.6 | 21.0 | VF |
| (b) | 1.0 | 23.8 | 50.4 | 16.6 | 4.4 | 2.0 | 1.0 | 0.6 | 0.2 | 24.8 | 67.0 | 0.8 | VC |
| 4108 | 0 | 0.2 | 21.0 | 37.8 | 9.4 | 10.0 | 7.6 | 7.6 | 6.4 | 0.2 | 58.8 | 14.0 | F |
| 4110 | 0.8 | 3.0 | 44.4 | 34.4 | 6.2 | 4.0 | 3.4 | 2.4 | 1.4 | 3.8 | 78.8 | 3.8 | MC |
| 4111 | 0 | 0.2 | 47.6 | 33.6 | 6.2 | 4.4 | 3.4 | 2.6 | 2.0 | 0.2 | 81.2 | 4.6 | C |
| 4112 | 0 | 0 | 8.6 | 56.2 | 12.8 | 9.2 | 6.6 | 4.4 | 2.2 | 0 | 64.8 | 6.6 | VF |
| 4114 | 0 | 0 | 11.2 | 52.8 | 12.2 | 9.2 | 7.0 | 4.6 | 3.0 | 0 | 63.0 | 7.6 | F |
| 4115 | 0 | 0.4 | 15.6 | 46.0 | 11.6 | 10.0 | 7.2 | 5.6 | 3.6 | 0.4 | 61.6 | 9.2 | F |
| 4116 | 0 | 0.4 | 23.4 | 39.0 | 9.6 | 10.4 | 8.2 | 6.0 | 3.0 | 0.4 | 62.4 | 9.0 | F |
| 4117 | 0.2 | 1.8 | 30.8 | 44.8 | 8.8 | 5.6 | 4.0 | 2.8 | 1.2 | 2.0 | 75.6 | 4.0 | MF |
| 4118 | 0 | 2.8 | 43.4 | 30.0 | 8.1 | 6.2 | 4.6 | 3.2 | 1.6 | 2.8 | 73.4 | 4.8 | MC |
| 4121 | 0 | 0.2 | 8.0 | 54.0 | 12.0 | 8.0 | 7.2 | 6.0 | 3.4 | 0.2 | 62.0 | 9.4 | VF |
| 4122 | 0 | 0.6 | 14.0 | 38.8 | 14.0 | 9.6 | 9.0 | 7.8 | 6.2 | 0.6 | 52.8 | 14.0 | VF |
| 4123 | 0 | 0.4 | 9.0 | 46.8 | 10.4 | 12.4 | 8.8 | 7.2 | 5.0 | 0.4 | 55.8 | 12.2 | VF |
| 4125 | 0 | 0 | 18.2 | 48.8 | 12.4 | 8.0 | 6.2 | 4.0 | 2.4 | 0 | 67.0 | 6.4 | F |
| 4132 | 0 | 1.0 | 34.4 | 37.8 | 8.8 | 6.6 | 4.2 | 3.8 | 3.4 | 1.0 | 72.2 | 7.2 | M |
| 4133 | 0 | 1.4 | 37.2 | 39.6 | 9.6 | 5.8 | 3.8 | 2.0 | 0.6 | 1.4 | 76.8 | 2.6 | M |
| 4134 | 0 | 0 | 26.4 | 44.6 | 11.6 | 7.2 | 5.2 | 3.2 | 1.8 | 0 | 71.0 | 5.0 | MF |
| 4135 | 0 | 0 | 16.6 | 49.6 | 10.4 | 9.8 | 6.8 | 4.4 | 2.4 | 0 | 66.2 | 6.8 | F |
| 4136 | 0 | 3.0 | 23.6 | 35.8 | 9.6 | 10.4 | 7.6 | 6.4 | 3.6 | 3.0 | 59.4 | 10.0 | F |
| 4138 | 0 | 0.6 | 32.2 | 45.6 | 8.8 | 5.6 | 3.8 | 2.4 | 1.0 | 0.6 | 77.8 | 3.4 | M |
| 4139 | 0 | 0.4 | 21.2 | 45.6 | 9.2 | 9.2 | 6.4 | 5.2 | 2.8 | 0.4 | 66.8 | 8.0 | MF |
| 4143(a) | no | sugar | | | | | | | | | | | |
| (b) | 0 | 0.4 | 24.4 | 46.8 | 8.0 | 7.6 | 5.6 | 4.4 | 2.8 | 0.4 | 71.2 | 7.2 | MF |
| 4144(a) | 0 | 1.6 | 41.6 | 38.0 | 8.0 | 4.4 | 3.6 | 2.0 | 0.8 | 1.6 | 79.6 | 2.8 | M |
| (b) | 0 | 0.4 | 22.8 | 50.0 | 11.0 | 6.4 | 4.8 | 3.0 | 1.6 | 0.4 | 72.8 | 4.6 | MF |
| 4145(a) | 0 | 1.0 | 27.8 | 35.2 | 11.2 | 9.2 | 7.0 | 5.8 | 2.8 | 1.0 | 63.0 | 8.6 | F |
| (b) | 0 | 14.0 | 55.4 | 18.8 | 5.0 | 3.0 | 2.0 | 1.4 | 0.4 | 14.0 | 74.2 | 1.8 | C |
| 4147 | 0 | 0.8 | 24.6 | 39.6 | 9.8 | 10.0 | 6.8 | 5.2 | 3.2 | 0.8 | 64.2 | 8.4 | F |
| 4149 | 0 | 0.4 | 21.8 | 50.0 | 8.2 | 7.4 | 5.8 | 4.0 | 2.4 | 0.4 | 71.8 | 6.4 | MF |
| 4150 | 0 | 0.4 | 23.8 | 44.6 | 9.0 | 7.6 | 5.8 | 5.2 | 3.6 | 0.4 | 68.4 | 8.8 | MF |
| 4151 | 0.4 | 1.6 | 30.8 | 44.8 | 10.4 | 5.8 | 3.6 | 2.0 | 0.6 | 2.0 | 75.6 | 2.6 | M |
| 4152 | 0 | 0.2 | 10.8 | 45.2 | 16.2 | 9.6 | 8.0 | 5.6 | 4.4 | 0.2 | 56.0 | 10.0 | VF |
| 4159 | 0 | 2.0 | 32.0 | 36.2 | 9.0 | 7.6 | 6.2 | 4.4 | 2.6 | 2.0 | 68.2 | 7.0 | MF |
| 4161 | no | sugar | | | | | | | | | | | |
| 4166 | 0 | 1.6 | 24.0 | 35.4 | 11.2 | 8.6 | 8.0 | 6.4 | 4.8 | 1.6 | 59.4 | 11.2 | F |
| 4167 | 0 | 0.8 | 21.4 | 48.8 | 9.8 | 9.0 | 6.0 | 3.0 | 1.2 | 0.8 | 70.2 | 4.2 | MF |
| 4169 | 0 | 0.2 | 17.6 | 40.4 | 10.2 | 8.6 | 7.8 | 7.2 | 8.0 | 0.2 | 58.0 | 15.2 | VF |
| 4173 | 0 | 0.4 | 9.6 | 36.0 | 14.8 | 14.0 | 12.0 | 9.2 | 4.0 | 0.4 | 45.6 | 13.2 | VF |
| 4176 | 0 | 0.2 | 18.8 | 56.2 | 10.4 | 6.8 | 3.6 | 2.4 | 1.6 | 0.2 | 75.0 | 4.0 | MF |
| 4180 | 0 | 0.4 | 24.6 | 44.2 | 8.4 | 8.0 | 5.8 | 5.0 | 3.6 | 0.4 | 68.8 | 8.6 | F |
| 4182 | 0 | 0.2 | 19.8 | 44.4 | 9.2 | 8.8 | 6.8 | 6.4 | 4.4 | 0.2 | 64.2 | 10.8 | F |
| 4191 | 15.4 | 41.8 | 29.2 | 10.6 | 2.0 | 0.6 | 0.2 | 0.2 | 0 | 57.2 | 39.8 | 0.2 | VC |
| 4194 | 0.2 | 4.8 | 42.0 | 34.8 | 9.2 | 4.0 | 2.6 | 1.6 | 0.8 | 5.0 | 76.8 | 2.4 | C |
| 4196 | 7.4 | 29.6 | 40.4 | 17.8 | 3.2 | 1.0 | 0.4 | 0.2 | 0 | 37.0 | 58.2 | 0.2 | VC |
| Average | 0.1 | 0.7 | 23.4 | 42.7 | 10.3 | 8.3 | 6.4 | 4.9 | 3.2 | 0.8 | 66.1 | 8.1 | F |
| 1940 Avg. | 0 | 1.6 | 32.4 | 38.1 | 8.8 | 7.8 | 4.3 | 4.2 | 2.7 | 1.6 | 70.5 | 6.9 | M |

## Table 9
## Screening Tests
## Steffen

| Sample | Percent Retained on Screens U.S.Nos. | | | | | | | | Thru | On | Thru 30 | Thru | Grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 100 | 100 | no.30 | On 50 | no.80 | |
| 4101 | 0 | 4.0 | 34.6 | 35.6 | 10.8 | 6.0 | 4.4 | 3.0 | 1.6 | 4.0 | 70.2 | 4.6 | M |
| 4102 | 0 | 0 | 27.6 | 41.4 | 13.0 | 7.0 | 5.6 | 3.6 | 2.2 | 0 | 69.0 | 5.8 | MF |
| 4104 | 0 | 3.4 | 29.4 | 36.2 | 11.2 | 6.6 | 5.8 | 4.4 | 3.0 | 3.4 | 65.6 | 7.4 | MF |
| 4107 | 0 | 0.4 | 15.2 | 46.0 | 12.0 | 9.0 | 7.4 | 6.0 | 4.0 | 0.4 | 61.2 | 10.0 | F |
| 4109 | 0 | 0.2 | 14.8 | 45.0 | 17.4 | 9.0 | 7.4 | 4.6 | 1.6 | 0.2 | 59.8 | 6.2 | F |
| 4113 | 0 | 1.0 | 24.4 | 44.0 | 12.8 | 7.2 | 5.4 | 3.4 | 1.8 | 1.0 | 68.4 | 5.2 | MF |
| 4119 | 0 | 1.0 | 22.2 | 43.6 | 10.4 | 8.4 | 7.0 | 5.0 | 2.4 | 1.0 | 65.8 | 7.4 | MF |
| 4120 | 0 | 0 | 16.0 | 43.6 | 11.2 | 7.4 | 7.2 | 6.8 | 7.8 | 0 | 59.6 | 14.6 | VF |
| 4124 | 0 | 0.6 | 16.4 | 48.6 | 14.2 | 7.8 | 5.8 | 4.0 | 2.6 | 0.6 | 65.0 | 6.6 | F |
| 4126 | 0 | 0.6 | 36.0 | 41.0 | 8.8 | 5.4 | 3.8 | 3.0 | 1.4 | 0.6 | 77.0 | 4.4 | M |
| 4127 | 0 | 2.4 | 37.6 | 37.0 | 9.2 | 5.6 | 4.0 | 2.6 | 1.6 | 2.4 | 74.6 | 4.2 | M |
| 4128(a) | 0 | 1.6 | 29.2 | 46.4 | 9.6 | 5.6 | 4.0 | 2.4 | 1.0 | 1.6 | 75.6 | 3.4 | M |
| (b) | no sugar | | | | | | | | | | | | |
| 4129 | 0 | 0.2 | 15.8 | 46.0 | 12.0 | 8.8 | 6.4 | 5.6 | 5.2 | 0.2 | 61.8 | 10.8 | F |
| 4130 | 0 | 0 | 15.2 | 48.4 | 10.4 | 8.6 | 7.2 | 6.0 | 4.2 | 0 | 63.6 | 10.2 | F |
| 4131 | 0 | 0 | 6.2 | 42.0 | 20.8 | 11.4 | 9.2 | 6.4 | 4.0 | 0 | 48.2 | 10.4 | VF |
| 4137 | 0 | 0.4 | 15.2 | 45.6 | 12.2 | 8.6 | 7.2 | 6.4 | 4.6 | 0.4 | 60.8 | 11.0 | F |
| 4140 | 0 | 0 | 15.2 | 48.4 | 10.4 | 8.6 | 7.2 | 6.0 | 4.2 | 0 | 63.6 | 10.2 | F |
| 4141 | 0 | 0.2 | 12.0 | 53.0 | 12.8 | 8.2 | 5.6 | 4.8 | 3.4 | 0.2 | 65.0 | 8.2 | F |
| 4142 | 0 | 0.4 | 17.6 | 44.8 | 11.6 | 7.2 | 7.2 | 6.4 | 4.8 | 0.4 | 62.4 | 11.2 | F |
| 4146 | 0 | 0.2 | 12.0 | 49.0 | 12.2 | 9.4 | 7.2 | 6.0 | 4.0 | 0.2 | 61.0 | 10.0 | F |
| 4153 | 0 | 0.6 | 8.8 | 58.8 | 10.2 | 8.0 | 5.6 | 4.8 | 3.2 | 0.6 | 67.6 | 8.0 | MF |
| 4155 | 0.2 | 2.0 | 32.4 | 43.4 | 9.4 | 5.6 | 3.8 | 2.4 | 0.8 | 2.2 | 75.8 | 3.2 | M |
| 4156(a) | 0 | 2.0 | 47.8 | 35.0 | 6.8 | 3.4 | 2.6 | 1.6 | 0.8 | 2.0 | 82.8 | 2.4 | MC |
| (b) | 0 | 0.2 | 25.6 | 49.0 | 9.4 | 6.4 | 4.2 | 3.2 | 2.0 | 0.2 | 74.6 | 5.2 | MF |
| 4157 | 0.4 | 1.0 | 12.0 | 53.0 | 13.2 | 8.8 | 6.0 | 3.6 | 2.0 | 1.4 | 65.0 | 5.6 | MF |
| 4158 | 0 | 3.2 | 47.2 | 35.6 | 6.2 | 4.0 | 2.2 | 1.2 | 0.4 | 3.2 | 82.8 | 1.6 | MC |
| 4160 | 0 | 0.6 | 19.0 | 50.8 | 10.4 | 7.6 | 5.4 | 3.8 | 2.0 | 0.6 | 69.8 | 5.8 | MF |
| 4162 | 0 | 0.4 | 13.6 | 50.8 | 15.6 | 8.8 | 6.0 | 3.2 | 1.6 | 0.4 | 64.4 | 4.8 | F |
| 4163 | 0 | 0.8 | 28.6 | 43.6 | 10.0 | 7.0 | 5.2 | 3.2 | 1.4 | 0.8 | 72.2 | 4.6 | MF |
| 4164(a) | 0 | 0 | 38.2 | 38.6 | 8.0 | 6.2 | 4.4 | 3.2 | 1.4 | 0 | 76.8 | 4.6 | M |
| (b) | 0 | 0 | 20.6 | 43.4 | 11.4 | 9.2 | 6.8 | 5.4 | 3.2 | 0 | 64.0 | 8.6 | F |
| 4165 | 0 | 0.8 | 30.6 | 40.0 | 8.8 | 6.6 | 5.0 | 4.8 | 3.4 | 0.8 | 70.6 | 8.2 | MF |
| 4168 | 0 | 0.2 | 8.2 | 36.6 | 17.2 | 11.0 | 9.4 | 9.4 | 8.0 | 0.2 | 44.8 | 17.4 | VF |
| 4171 | 0 | 0.4 | 21.6 | 51.2 | 10.4 | 6.8 | 4.8 | 3.2 | 1.6 | 0.4 | 72.8 | 4.8 | MF |
| 4172 | 0 | 0 | 7.2 | 48.0 | 12.8 | 10.0 | 8.0 | 7.2 | 6.8 | 0 | 55.2 | 14.0 | VF |
| 4175 | 0 | 0.6 | 25.8 | 43.0 | 10.0 | 8.2 | 6.0 | 4.2 | 2.2 | 0.6 | 68.8 | 6.4 | MF |
| 4177 | 0 | 0 | 26.0 | 48.4 | 9.4 | 6.2 | 4.2 | 3.4 | 2.4 | 0 | 74.4 | 5.8 | MF |
| 4178 | 0 | 0 | 28.0 | 42.8 | 5.6 | 6.8 | 6.0 | 4.4 | 2.4 | 0 | 70.8 | 6.8 | MF |
| 4179 | 0 | 0 | 4.8 | 46.8 | 16.4 | 10.6 | 7.8 | 7.4 | 6.2 | 0 | 51.6 | 13.6 | VF |
| 4183 | 0 | 0.4 | 30.0 | 50.4 | 8.4 | 4.8 | 3.2 | 2.0 | 0.8 | 0.4 | 80.4 | 2.8 | M |
| 4184 | 0 | 0 | 42.2 | 35.4 | 7.8 | 4.6 | 4.2 | 3.6 | 2.2 | 0 | 77.6 | 5.8 | M |
| 4190 | 0.2 | 1.6 | 14.8 | 46.0 | 14.0 | 8.4 | 6.4 | 4.4 | 4.2 | 1.8 | 60.8 | 8.6 | F |
| 4195 | 0.4 | 4.4 | 40.0 | 38.0 | 8.0 | 4.0 | 2.8 | 1.6 | 0.8 | 4.8 | 78.0 | 2.4 | C |
| Average | 0 | 0.7 | 22.7 | 44.7 | 11.3 | 7.5 | 5.8 | 4.5 | 2.8 | 0.7 | 67.4 | 7.3 | F |
| 1940 Avg. | 0 | 0.7 | 27.5 | 41.3 | 9.8 | 8.2 | 4.8 | 4.6 | 3.1 | 0.7 | 68.8 | 7.7 | F |

Table 10
Regional Averages
Non-Steffen

| | 1. | | 2. | | 3. | | 4. | |
|---|---|---|---|---|---|---|---|---|
| | 1940 | 1941 | 1940 | 1941 | 1940 | 1941 | 1940 | 1941 |
| Sucrose of beets------- | 15.6 | 14.8 | 16.9 | 17.0 | 15.2 | 15.8 | 16.3 | 16.8 |
| Purity Diffusion Juice- | 86.3 | 86.0 | 87.8 | 87.3 | 86.3 | 87.1 | 88.3 | 88.7 |
| Lime used (lbs.per ton) | 2.35 | 2.45 | 2.65 | 2.44 | 1.60 | 1.56 | 2.25 | 2.23 |
| Soda Ash used,lbs.ton-- | 0.03 | 0.10 | 0.16 | 0.19 | 0.15 | 0.09 | 0.18 | 0.00 |
| Lime Salts, Std. Liq.-- | 0.035 | 0.051 | 0.038 | 0.036 | 0.025 | 0.024 | 0.036 | 0.027 |
| Sulphur used,lbs.ton--- | 0.42 | 0.36 | 0.24 | 0.25 | 0.53 | 0.52 | 0.46 | 0.45 |
| pH Thin Juice --------- | 8.4 | 8.6 | 8.4 | 8.5 | 8.0 | 8.1 | 8.1 | 7.9 |
| pH Thick Juice--------- | 8.6 | 8.6 | 8.7 | 8.8 | 8.7 | 8.7 | 8.4 | 8.4 |
| pH White Massecuite---- | 8.3 | 8.0 | 8.6 | 8.8 | 8.6 | 8.6 | 8.4 | 8.3 |
| pH White Sugar Solution | 6.9 | 6.9 | 6.9 | 6.7 | 6.9 | 6.8 | 6.9 | 6.8 |
| Reducing Sug.,Barley Candy | 2.29% | 1.43 | 2.76 | 1.74 | 2.79 | 1.60 | 2.37 | 1.63 |
| Purity,White Massecuite- | 91.3 | 91.6 | 93.5 | 94.0 | 91.5 | 91.9 | 92.1 | 92.3 |
| Purity White Sugar(dry) | --- | 99.968 | -- | 99.979 | --- | 99.978 | --- | 99.976 |
| Carbonate Ash,p.p.m.--- | 103 | 100 | 70 | 60 | 89 | 78 | 96 | 92 |
| Sulphated Ash,p.p.m.--- | 131 | 132 | 90 | 84 | 112 | 101 | 123 | 119 |
| Total Salts(est'd),p.p.m. | 161 | 168 | 109 | 103 | 122 | 115 | 136 | 133 |
| Specific Cond.X $10^6$ | 24.6 | 24.9 | 18.4 | 16.2 | 23.4 | 21.4 | 25.0 | 24.2 |
| Carb.Ash-Cond.Factor,$10^6$ | 419 | 402 | 380 | 370 | 380 | 364 | 384 | 380 |
| Sulp.Ash-Cond.Factor--- | 532 | 530 | 489 | 518 | 479 | 472 | 492 | 492 |
| Salts-Cond-Factor------ | 654 | 675 | 592 | 636 | 521 | 537 | 544 | 550 |
| $SO_2$ in sugar,p.p.m.---- | 6 | 7 | 3 | 4 | 9 | 9 | 12 | 14 |
| $SO_3$ " " " " ----- | 6 | 7 | 5 | 6 | 11 | 10 | 7 | 8 |
| Cl " " " " ----- | 2 | 3 | 5 | 4 | 9 | 7 | 7 | 5 |
| Est'd Organic Acid,p.p.m. | 82 | 84 | 55 | 48 | 39 | 36 | 51 | 45 |
| Organic Salts,% total - | 75.8 | 74.4 | 75.2 | 69.4 | 47.5 | 46.9 | 55.9 | 50.4 |
| Inorganic Salts,%total | 24.2 | 25.6 | 24.8 | 30.6 | 52.5 | 53.1 | 44.1 | 49.6 |
| $SiO_2$ in sugar,p.p.m. -- | 7 | 11 | 6 | 3 | 7 | 6 | 8 | 4 |
| CaO in sugar,p.p.m. -- | 5 | 6 | 3 | 6 | 2 | 3 | 3 | 4 |
| $K_2O$ in sugar,est'd p.p.m. | 55 | 37 | 20 | 24 | 39 | 31 | 45 | 49 |
| $Na_2O$ " " " """" | 3 | 16 | 17 | 9 | 13 | 14 | 11 | 5 |
| Color Sugar Sol'n,B-K Ind. | 8.4 | 12.2 | 8.2 | 7.5 | 5.9 | 6.2 | 7.0 | 7.6 |
| " " " N-W(-log t) | -- | 2.42 | -- | 1.32 | -- | 1.31 | -- | 1.19 |
| Turbidity, B-K Index ---- | 17.2 | 16.4 | 15.8 | 10.0 | 12.7 | 8.9 | 17.2 | 10.8 |
| " , N-W(-log t)$10^3$ | -- | 6.65 | -- | 4.16 | -- | 3.43 | -- | 4.78 |
| Color Candy Sol'n,B-K Ind | 13.9 | 12.5 | 10.2 | 8.1 | 10.5 | 9.4 | 13.3 | 10.6 |
| " " " N-W(-log t) | -- | 28.84 | -- | 18.28 | -- | 21.05 | -- | 24.08 |
| Increase Color,-log t basis-- | | 26.42 | -- | 16.96 | -- | 19.74 | -- | 22.89 |
| Nitrogen(amino) ,p.p.m. | 17 | 16 | 16 | 11 | 11 | 11 | 14 | 11 |
| Reflectance,whole sugar-- | 92.3 | 91.1 | 93.4 | 92.2 | 92.7 | 92.0 | 93.2 | 92.3 |
| " (blue Screen) --- | -- | 88.9 | -- | 90.3 | -- | 90.2 | -- | 90.6 |
| " 40-50 Fraction -- | -- | 90.2 | -- | 91.3 | -- | 91.4 | -- | 92.0 |
| Foaming Test,Old,Maximum | 95 | 93 | 90 | 88 | 96 | 102 | 91 | 94 |
| " " ,New, " | -- | 121 | -- | 108 | -- | 122 | -- | 109 |
| Formula Rating,Old formula | 63.5 | 60.7 | 68.7 | 76.1 | 71.6 | 76.2 | 65.2 | 71.0 |
| " " ,New " | -- | 85.5 | -- | 93.7 | -- | 91.0 | -- | 91.7 |
| Yeast Inoculum Multiple | 11.0 | 7.1 | 8.8 | 6.2 | 8.2 | 6.3 | 7.1 | 5.2 |

### Table 10
### Regional Averages
### Steffen

| | 1. | | 2. | | 3. | | 4. | |
|---|---|---|---|---|---|---|---|---|
| | 1940 | 1941 | 1940 | 1941 | 1940 | 1941 | 1940 | 1941 |
| Sucrose of Beets | 16.0 | 14.8 | 17.6 | 16.8 | 15.0 | 15.2 | 16.0 | 16.6 |
| Purity Diffusion Juice | 86.5 | 85.5 | 85.9 | 85.3 | 85.9 | 86.3 | 88.2 | 88.5 |
| Molasses Worked, % beets | 6.23 | 6.08 | 7.21 | 7.81 | 5.89 | 5.38 | 6.16 | 5.38 |
| Lime used, % per 1% Mol. | 0.69 | 0.72 | 0.54 | 0.57 | 0.58 | 0.59 | 0.59 | 0.64 |
| Soda Ash used, lbs per ton | 0.61 | 0.73 | 1.00 | 1.21 | 0.47 | 0.30 | 0.35 | 0.25 |
| Lime Salts, Std. Liq. | 0.066 | 0.067 | 0.078 | 0.062 | 0.037 | 0.045 | 0.055 | 0.046 |
| Sulphur used, lbs per ton | 0.32 | 0.29 | 0.32 | 0.33 | 0.46 | 0.46 | 0.32 | 0.33 |
| pH Thin Juice | 8.5 | 8.6 | 8.7 | 8.7 | 8.0 | 8.2 | 8.2 | 8.2 |
| pH Thick Juice | 8.5 | 8.5 | 8.0 | 8.2 | 8.4 | 8.5 | 7.9 | 8.1 |
| pH White Massecuite | 8.2 | 8.0 | 8.1 | 7.8 | 8.3 | 8.3 | 7.9 | 8.0 |
| pH White Sugar Solution | 6.8 | 6.8 | 6.6 | 6.7 | 6.9 | 6.7 | 6.6 | 6.6 |
| Reducing Sugar Candy | 2.64% | 1.42 | 2.71% | 1.50 | 2.52% | 1.60 | 2.62 | 1.66 |
| Purity White Massecuite | 92.5 | 91.9 | 93.0 | 94.1 | 91.7 | 92.0 | 92.4 | 92.6 |
| Purity White Sugar (dry) | -- | 99.967 | -- | 99.979 | -- | 99.973 | -- | 99.974 |
| Carbonate Ash, p.p.m. | 106 | 108 | 74 | 62 | 121 | 103 | 98 | 96 |
| Sulphated Ash, P.P.M. | 136 | 144 | 94 | 82 | 154 | 134 | 128 | 127 |
| Total Salts (est'd) p.p.m. | 173 | 190 | 118 | 108 | 178 | 162 | 158 | 160 |
| Specific Conductivity ($10^6$) | 26.0 | 27.0 | 17.0 | 15.8 | 31.6 | 27.5 | 24.2 | 23.6 |
| Carb. Ash-Cond. Factor ($10^6$) | 408 | 400 | 435 | 392 | 383 | 375 | 405 | 407 |
| Sulp.-Ash-Cond Factor " | 523 | 533 | 553 | 519 | 487 | 487 | 529 | 538 |
| Tot. Salts-Cond. Factor " | 665 | 704 | 694 | 684 | 563 | 589 | 653 | 678 |
| $SO_2$ in sugar, p.p.m. | 5 | 4 | 2 | 3 | 9 | 9 | 7 | 8 |
| $SO_3$ in sugar, p.p.m. | 7 | 6 | 4 | 5 | 11 | 10 | 6 | 6 |
| Cl in sugar, p.p.m. | 2 | 2 | 3 | 4 | 12 | 7 | 3 | 6 |
| Org. Acd. (est'd) p.p.m. | 95 | 107 | 65 | 55 | 75 | 70 | 67 | 78 |
| Organic Salts, % total | 82.1 | 83.7 | 82.2 | 75.9 | 62.9 | 64.2 | 63.3 | 72.5 |
| Inorganic Salts, % total | 17.9 | 16.3 | 17.8 | 24.1 | 37.1 | 35.8 | 36.7 | 27.5 |
| $SiO_2$ in sugar, p.p.m. | 8 | 5 | 7 | 4 | 9 | 4 | 4 | 4 |
| CaO in sugar, p.p.m. | 5 | 7 | 5 | 4 | 3 | 4 | 4 | 7 |
| $K_2O$ in sugar (est'd) p.p.m. | 47 | 54 | 23 | 16 | 46 | 46 | 39 | 38 |
| Na20 in sugar (est'd) p.p.m. | 13 | 10 | 13 | 18 | 24 | 14 | 17 | 19 |
| Color Sugar Sol'n, B-K Index | 10.0 | 12.7 | 9.4 | 9.5 | 6.9 | 7.5 | 10.1 | 12.0 |
| Turbidity Sugar, B-K Index | 19.4 | 11.4 | 13.2 | 8.7 | 12.4 | 8.4 | 17.4 | 16.1 |
| Color Sugar Sol'n, N-W (-log t) | -- | 2.73 | -- | 1.71 | -- | 1.06 | -- | 1.15 |
| Turbidity, N-W (-log t) $10^3$ | -- | 4.61 | -- | 3.11 | -- | 3.51 | -- | 7.15 |
| Color Candy Sol'n, B-K Index | 14.8 | 13.6 | 9.4 | 8.0 | 12.8 | 10.8 | 13.3 | 11.7 |
| Color Candy NW (-log t) $10^3$ | -- | 30.84 | -- | 15.72 | -- | 24.26 | -- | 22.66 |
| Color Increase (- log t) basis | -- | 28.11 | -- | 14.01 | -- | 23.20 | -- | 21.51 |
| Nitrogen (amino) p.p.m. | (13.5) | 16.3 | (13.0) | 11.8 | (14.4) | 11.9 | (16.0) | 10.8 |
| Reflectance, whole sugar, B-K | 92.0 | 91.1 | 93.3 | 91.7 | 93.3 | 92.0 | 93.9 | 92.4 |
| " (blue screen) " " | -- | 88.5 | -- | 89.8 | -- | 90.2 | -- | 90.9 |
| " 40-50 fraction " | -- | 90.4 | -- | 91.0 | -- | 91.3 | -- | 91.8 |
| Foaming Test, Old, Maximum | 93 | 90 | 104 | 96 | 95 | 99 | 88 | 91 |
| " " , New, " | -- | 107 | -- | 116 | -- | 120 | -- | 107 |
| " " Avg. Minimum | 81 | 83 | 83 | 86 | 84 | 85 | 84 | 84 |
| Formula Rating, Old Formula | 59.5 | 64.7 | 69.8 | 75.3 | 67.7 | 73.0 | 62.0 | 61.5 |
| " " , New " | -- | 88.1 | -- | 92.7 | -- | 90.8 | -- | 90.0 |
| Yeast Inoculum Multiple | 7.4 | 6.4 | 8.1 | 5.9 | 7.5 | 7.1 | 6.9 | 7.6 |

## PART II.

# REPORT ON BIOLOGICAL STUDIES OF SUGARS

By H. H. Hall and Edna E. Dicks

The biological quality of the samples was determined by examination for substances which stimulate the multiplication of yeast cells in solutions and for the number of certain thermophilic and mesophilic microorganisms. Subsamples of the same factory composites as used for the chemical analysis were used for this study. The results are given in two parts, namely: (1) The examination for yeast stimulating substances, and (2) the examination for thermophilic and mesophilic microorganisms.

No attempt has been made to establish a rating scheme whereby the results of the above examinations could be combined to give a numerical value for the biological quality. Although such a rating system has been suggested and might be desirable for arriving at an overall biological quality value, it is felt that it would not reveal a great amount of information from the standpoint of factory operation. Also, consideration has been given to the possibility of advantageously including the data in the rating formula given in the preceding part of this report. This did not seem desirable because of the lack of significant correlation with the chemical data.

## EXAMINATION FOR YEAST-STIMULATING SUBSTANCES

The extent of yeast cell multiplication in sugar solutions depends largely upon the amount of non-sugar impurities present which can be assimilated by the cell in the form of growth-promoting substances. Such substances in yeast metabolism are analogous to vitamins in human and animal nutrition. A large number of substances have been identified which are utilized by yeast cells as growth stimulants and the source of each has been largely determined. The complex growth promoting substance which occurs in sugar has been studied and its nature and properties discussed in recent issues of this report. Its role in the keeping quality of beverages and similar solutions which are subject to yeast contamination has been determined and likewise discussed in these reports.

Again this year the relative amount of stimulant was determined in the 87 samples by the method described in an article by Hall, James and Stuart, Ind. Eng. Chem., vol. 25, p. 1052 (1933). One hundred cubic centimeters of sterilized ten percent solutions of each sugar were inoculated with approximately 50,000 yeast cells per cc. The yeast crop that developed during three days of incubation was determined and calculated in terms of the multiple of the number of cells inoculated into each solution. The samples are ranked in ascending order of their yeast inoculum multiples and are identified by their sample numbers. The results are given in Table I.

The average yeast inoculum multiple for all samples this year is 6.6 which is in contrast to 8.0 for the campaign year 1940 and 9.1 for 1939. Again this year a relationship exists between the yeast inoculum multiple and the ash content of the sugar. The average ash content of 49 samples having yeast inoculum multiples up to and including the average 6.6 is .0082 percent, while the average ash content of 38 samples having multiples above 6.8 is .0101 percent. This relationship, which has existed in other years, is shown in the following tabular data:

| Year | Yeast Inoculum Multiple Av. | Ash Percent Av. | Ash % in Samples below Av. Multiple | Ash % in Samples above Av. Multiple |
|---|---|---|---|---|
| 1941 | 6.6 | .0091 | .0082 | .0101 |
| 1940 | 8.0 | .0099 | .0095 | .0104 |
| 1939 | 9.1 | .0110 | .0104 | .0117 |

An examination of the analysis of the individual samples comprising the two groups, i.e., those samples with multiples above and below the average, indicates

TABLE I

Ranking of Sugar Samples Collected During 1941 Campaign

| Sample Number | Rank | Yeast Inoculum Multiple | Sample Number | Rank | Yeast Inoculum Multiple |
|---|---|---|---|---|---|
| 4153 | 1 | 1.0 | 4133 | 45 | 6.6 |
| 4139 | 2 | 1.0 | 4119 | 46 | 6.6 |
| 4164B | 3 | 1.6 | 4144A | 47 | 6.6 |
| 4156A | 4 | 1.6 | 4178 | 48 | 6.6 |
| 4111 | 5 | 2.0 | 4182 | 49 | 6.6 |
| 4166 | 6 | 2.2 | 4108 | 50 | 6.8 |
| 4161 | 7 | 2.4 | 4124 | 51 | 6.8 |
| 4190 | 8 | 2.8 | 4110 | 52 | 6.8 |
| 4105 | 9 | 3.2 | 4116 | 53 | 7.0 |
| 4149 | 10 | 3.2 | 4136 | 54 | 7.2 |
| 4117 | 11 | 3.2 | 4137 | 55 | 7.4 |
| 4145 | 12 | 3.4 | 4164A | 56 | 7.4 |
| 4144B | 13 | 3.4 | 4104 | 57 | 7.4 |
| 4171 | 14 | 3.4 | 4121 | 58 | 7.5 |
| 4156B | 15 | 3.4 | 4177 | 59 | 7.6 |
| 4132 | 16 | 3.6 | 4134 | 60 | 8.0 |
| 4160 | 17 | 3.6 | 4157 | 61 | 8.0 |
| 4109 | 18 | 3.8 | 4120 | 62 | 8.0 |
| 4102 | 19 | 4.2 | 4112 | 63 | 8.2 |
| 4158 | 20 | 4.2 | 4167 | 64 | 8.2 |
| 4123 | 21 | 4.4 | 4162 | 65 | 8.4 |
| 4122 | 22 | 4.6 | 4140 | 66 | 8.4 |
| 4103 | 23 | 4.6 | 4194 | 67 | 8.6 |
| 4118 | 24 | 4.8 | 4191 | 68 | 8.6 |
| 4114 | 25 | 4.8 | 4131 | 69 | 8.8 |
| 4184 | 26 | 4.8 | 4155 | 70 | 9.0 |
| 4107 | 27 | 4.8 | 4175 | 71 | 9.8 |
| 4146 | 28 | 5.0 | 4147 | 72 | 10.0 |
| 4101 | 29 | 5.0 | 4113 | 73 | 10.0 |
| 4127 | 30 | 5.0 | 4173 | 74 | 10.0 |
| 4150 | 31 | 5.0 | 4106 | 75 | 10.2 |
| 4130 | 32 | 5.2 | 4179 | 76 | 10.4 |
| 4115 | 33 | 5.4 | 4196 | 77 | 10.4 |
| 4143 | 34 | 5.4 | 4129 | 78 | 10.6 |
| 4128 | 35 | 5.4 | 4125 | 79 | 10.6 |
| 4138 | 36 | 5.6 | 4172 | 80 | 10.8 |
| 4126 | 37 | 5.8 | 4152 | 81 | 11.4 |
| 4183 | 38 | 5.8 | 4142 | 82 | 11.8 |
| 4176 | 39 | 6.0 | 4195 | 83 | 12.2 |
| 4180 | 40 | 6.0 | 4151 | 84 | 12.6 |
| 4135 | 41 | 6.2 | 4141 | 85 | 13.4 |
| 4168 | 42 | 6.4 | 4169 | 86 | 14.6 |
| 4163 | 43 | 6.4 | 4165 | 87 | 16.6 |
| 4159 | 44 | 6.6 |  |  |  |

that the relationship is not an exact one. There are a number of samples that, although having low multiples, they have ash values considerably above the average of .0091 percent. Also, there are a number of samples which have high yeast inoculum multiples and low ash values.

The data were further analyzed to show the relationship between the yeast inoculum multiple and ash values in Steffen and non-Steffen samples for the four geographic areas. The results are given in Table II.

Table II

COMPARATIVE AMOUNTS OF YEAST STIMULANT BY GEOGRAPHIC AREAS, STEFFEN AND NON-STEFFEN FACTORIES FOR 1941 AND 1940 CAMPAIGNS

| Area | I | | II | | III | | IV | |
|---|---|---|---|---|---|---|---|---|
| | S | N.S. | S | N.S. | S | N.S. | S | N.S. |
| 1941 Campaign | | | | | | | | |
| No. factories | 11 | 11 | 7 | 5 | 15 | 15 | 8 | 10 |
| Yeast inoc. multiple | 6.4 | 7.1 | 5.9 | 6.2 | 7.1 | 6.3 | 7.6 | 5.2 |
| Ash, percent | .0106 | .0100 | .0062 | .0060 | .0103 | .0078 | .0096 | .0092 |
| (1940 Campaign) | | | | | | | | |
| No. factories | 11 | 11 | 7 | 5 | 16 | 15 | 9 | 11 |
| Yeast inoc. multiple | 7.4 | 11.0 | 8.1 | 8.8 | 7.5 | 8.2 | 6.9 | 7.1 |
| Ash, percent | .0108 | .0103 | .0074 | .0070 | .0121 | .0089 | .0098 | .0096 |

It is interesting to note that although the average ash values are higher for the Steffen samples in the four areas the average yeast inoculum multiples are lower in areas I and II than in areas III and IV for the Steffen group. This is contrary to the results obtained from the 1940 samples, which showed that the Steffen samples in the four groups had higher ash values than the non-Steffen samples but yet had lower yeast inoculum multiples. These results tend to further invalidate the relationship shown to exist between the ash values and yeast inoculum multiples for the samples regardless of the geographic area from which they were derived.

There was no exact relationship found to exist between the amount of organic impurities and the relative amounts of stimulant present, although the stimulant is a complex composed of organic compounds. This lack of correlation may be due to the presence of the stimulative substance in amounts too small to be significantly associated with other measurable impurities. Despite the apparent lack of an exact correlation between the amounts of stimulative substances and measured impurities there is a useful application that can be made of the results obtained.

In the 1936 report results were given which showed that increased amounts of wash water per basket of sugar markedly reduced the yeast inoculum multiple. Reductions ranging from 34 to 73 percent of the stimulant were obtained in four factories when the amount of wash water normally used was increased six quarts per basket of sugar. These results and others by Hall and James, Facts About Sugar, June, 1936, showed that the stimulative substance is located at or near the crystal surface and that its removal is facilitated by complete removal of the adhering mother liquor and a small amount of the ccystal surface. It was likewise found that large numbers of microorganisms are eliminated by increased amounts of water, so it is evident that a more thorough elimination of impurities may be effected by adequate washing. At least, it would be desirable for those factories having high yeast inoculum multiples or large numbers of bacteria in the sugar to investigate the adequacy of washing.

## BACTERIOLOGICAL EXAMINATION

The samples were examined again this year for the presence and numbers of organisms such as would influence the use of the sugar in certain food products. The usual examination was made for thermophilic bacteria in order to determine their suitability for canning purposes. Also, examination was made for such mesophilic organisms as would influence the quality of dairy products, frozen foods and desserts, beverages, etc.

The methods that were used are described in the report issued last year and also in the Official and Tentative Methods of the Association of Official Agricultural Chemists, Fifth Edition, 1941, pp. 642-3. Although the bacterial standards that have been adopted for canning grade sugar were given in the report issued last year, they are again called to your attention. They are based on the types and numbers of the thermophilic bacterial spores and for the purposes of this report they are as follows:

Total Aerobic Thermophilic Spores, shall not exceed 125 spores per 10 grams of sugar.

Aerobic Flat Sour Spores, shall not exceed 50 spores per 10 grams of sugar.

Anaerobic Sulfide Spoilage Spores, shall not exceed 5 spores per 10 grams of sugar.

Anaerobic Thermophilic Hard Swell Spores, shall not be present in more than four of the six tubes of media inoculated with the test sample. Standards have not been established for mesophilic organisms although for the beverage industry it has been suggested that the total plate count should not exceed 100 organisms per gram of sugar. Almost complete freedom from molds and yeast is required. The results of the examination of the samples for thermophilic and mesophilic organisms are given in Table III.

## TABLE III

### Bacteriological Examination of 1941 Sugars

| | Thermophilic Bacteria | | | | Mesophilic Organisms | | | |
|---|---|---|---|---|---|---|---|---|
| | Aerobes | | Anaerobes | | Aerobic Bacteria | | Yeast | Molds |
| Sample Number | Total Count per 10 g. | Flat Sour per 10 g. | Sulfide Spores per 10 g. | Hard Swell % Tubes With Growth | Total per 1.0 g. | Acid per 1.0 g. | Total per 1.0 g. | Number Colonies per 1.0 g. |
| 4101 | 215 | 210 | 0 | 0 | 17 | 1 | 0 | 0 |
| 4102 | 5 | 0 | 0 | 0 | 7 | 4 | 0 | 0 |
| 4103 | 5 | 5 | 0 | 0 | 3 | 2 | 0 | 0 |
| 4104 | 30 | 20 | 0 | 0 | 18 | 2 | 0 | 0 |
| 4105 | 10 | 5 | 0 | 0 | 10 | 1 | 0 | 1 |
| 4106 | 20 | 10 | 0 | 0 | 67 | 58 | 0 | 0 |
| 4107 | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 1 |
| 4108 | 0 | 0 | 0 | 0 | 17 | 5 | 0 | 0 |
| 4109 | 45 | 30 | 0 | 0 | 36 | 9 | 0 | 0 |
| 4110 | 0 | 0 | 0 | 0 | 24 | 6 | 0 | 0 |
| 4111 | 5 | 5 | 0 | 0 | 13 | 5 | 0 | 5 |
| 4112 | 5 | 5 | 0 | 0 | 27 | 8 | 1 | 0 |
| 4113 | 35 | 30 | 0 | 0 | 25 | 20 | 0 | 0 |
| 4114 | 10 | 0 | 0 | 0 | 44 | 15 | 0 | 0 |
| 4115 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4116 | 5 | 5 | 0 | 0 | 1 | 1 | 0 | 0 |
| 4117 | 0 | 0 | 0 | 17 | 7 | 1 | 0 | 0 |
| 4118 | 10 | 10 | 0 | 0 | 35 | 5 | 0 | 0 |
| 4119 | 5 | 5 | 0 | 0 | 22 | 4 | 0 | 0 |
| 4120 | 135 | 120 | 3 | 0 | 145 | 125 | 0 | 7 |
| 4121 | 15 | 5 | 0 | 0 | 6 | 2 | 0 | 2 |
| 4122 | 0 | 0 | 0 | 0 | 32 | 5 | 0 | 2 |
| 4123 | 5 | 5 | 0 | 17 | 22 | 2 | 0 | 0 |
| 4124 | 15 | 15 | 0 | 0 | 30 | 20 | 0 | 1 |
| 4125 | 15 | 15 | 0 | 0 | 35 | 35 | 0 | 0 |
| 4126 | 0 | 0 | 0 | 0 | 56 | 13 | 0 | 1 |

## TABLE III (continued)

### Bacteriological Examination of 1941 Sugars

| | Thermophilic Bacteria | | | | Mesophilic Organisms | | | |
|---|---|---|---|---|---|---|---|---|
| | Aerobes | | Anaerobes | | Aerobic Bacteria | | Yeast | Molds |
| Sample Number | Total Count per 10 g. | Flat Sour per 10 g. | Sulfide Spores per 10 g. | Hard Swell % Tubes With Growth | Total per 1.0 g. | Acid per 1.0 g. | Total per 1.0 g. | Number Colonies per 1.0 g. |
| 4127 | 40 | 10 | 0 | 0 | 126 | 27 | 0 | 0 |
| 4128 | 250 | 130 | 0 | 0 | 135 | 120 | 0 | 1 |
| 4129 | 70 | 70 | 0 | 33 | 20 | 4 | 0 | 0 |
| 4130 | 5 | 0 | 0 | 0 | 13 | 5 | 0 | 4 |
| 4131 | 20 | 15 | 0 | 0 | 50 | 25 | 0 | 0 |
| 4132 | 0 | 0 | 0 | 0 | 21 | 1 | 0 | 1 |
| 4133 | 45 | 45 | 0 | 0 | 43 | 18 | 0 | 2 |
| 4134 | 40 | 35 | 0 | 17 | 27 | 7 | 0 | 0 |
| 4135 | 15 | 15 | 0 | 0 | 16 | 5 | 0 | 0 |
| 4136 | 30 | 25 | 0 | 0 | 130 | 122 | 0 | 1 |
| 4137 | 35 | 15 | 0 | 0 | 50 | 25 | 0 | 0 |
| 4138 | 140 | 130 | 0 | 0 | 85 | 28 | 0 | 1 |
| 4139 | 5 | 0 | 0 | 0 | 30 | 3 | 0 | 0 |
| 4140 | 30 | 30 | 0 | 0 | 45 | 10 | 0 | 0 |
| 4141 | 0 | 0 | 0 | 0 | 57 | 16 | 0 | 0 |
| 4142 | 40 | 40 | 0 | 33 | 20 | 4 | 0 | 0 |
| 4143 | 35 | 25 | 0 | 0 | 12 | 3 | 0 | 0 |
| 4144A | 15 | 10 | 0 | 0 | 10 | 10 | 0 | 0 |
| 4144B | 30 | 25 | 0 | 0 | 36 | 26 | 0 | 2 |
| 4145 | 15 | 10 | 0 | 17 | 14 | 4 | 0 | 1 |
| 4146 | 10 | 10 | 0 | 0 | 8 | 1 | 0 | 2 |
| 4147 | 45 | 40 | 0 | 17 | 178 | 175 | 0 | 0 |
| 4149 | 0 | 0 | 0 | 0 | 67 | 63 | 0 | 0 |
| 4150 | 60 | 45 | 0 | 0 | 50 | 3 | 0 | 0 |
| 4151 | 1090 | 1090 | 0 | 33 | 29 | 15 | 0 | 0 |
| 4152 | 475 | 470 | 0 | 33 | 55 | 20 | 0 | 3 |
| 4153 | 0 | 0 | 0 | 0 | 155 | 7 | 0 | 1 |
| 4155 | 15 | 10 | 0 | 0 | 225 | 225 | 0 | 8 |
| 4156A | 0 | 0 | 0 | 0 | 18 | 3 | 0 | 0 |
| 4156B | 5 | 0 | 0 | 0 | 36 | 6 | 0 | 1 |
| 4157 | 25 | 10 | 0 | 0 | 14 | 9 | 0 | 2 |

TABLE III (continued)

Bacteriological Examination of 1941 Sugars

| | Thermophilic Bacteria | | | | Mesophilic Organisms | | | |
|---|---|---|---|---|---|---|---|---|
| | Aerobes | | Anaerobes | | Aerobic Bacteria | | Yeast | Molds |
| Sample Number | Total Count per 10 g. | Flat Sour per 10 g. | Sulfide Spores per 10 g. | Hard Swell % Tubes With Growth | Total per 1.0 g. | Acid per 1.0 g. | Total per 1.0 g. | Number Colonies per 1.0 g. |
| 4158 | 35 | 35 | 0 | 0 | 17 | 3 | 0 | 0 |
| 4159 | 0 | 0 | 0 | 0 | 5 | 3 | 0 | 0 |
| 4160 | 40 | 30 | 3 | 0 | 20 | 11 | 0 | 0 |
| 4161 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 |
| 4162 | 105 | 90 | 0 | 0 | 28 | 4 | 0 | 9 |
| 4163 | 5 | 5 | 3 | 0 | 140 | 15 | 0 | 2 |
| 4164A | 10 | 10 | 0 | 0 | 17 | 12 | 0 | 0 |
| 4164B | 15 | 15 | 0 | 0 | 3 | 3 | 0 | 0 |
| 4165 | 50 | 50 | 0 | 0 | 13 | 4 | 0 | 0 |
| 4166 | 30 | 25 | 0 | 0 | 2 | 1 | 0 | 0 |
| 4167 | 15 | 5 | 0 | 0 | 10 | 0 | 0 | 0 |
| 4168 | 55 | 50 | 0 | 0 | 69 | 8 | 0 | 0 |
| 4169 | 0 | 0 | 0 | 17 | 85 | 8 | 0 | 0 |
| 4171 | 10 | 0 | 0 | 0 | 12 | 3 | 0 | 0 |
| 4172 | 10 | 10 | 0 | 0 | 358 | - | 0 | 1 |
| 4173 | 15 | 5 | 0 | 0 | 22 | 5 | 0 | 1 |
| 4175 | 115 | 105 | 0 | 0 | 165 | 165 | 0 | 2 |
| 4176 | 5 | 5 | 0 | 0 | 13 | 5 | 0 | 0 |
| 4177 | 65 | 40 | 0 | 0 | 42 | 8 | 0 | 5 |
| 4178 | 30 | 20 | 0 | 0 | 14 | 5 | 0 | 1 |
| 4179 | 5 | 5 | 0 | 0 | 25 | 10 | 0 | 1 |
| 4180 | 5 | 5 | 0 | 0 | 36 | 16 | 0 | 0 |
| 4182 | 20 | 20 | 0 | 0 | 27 | 5 | 0 | 0 |
| 4183 | 0 | 0 | 0 | 0 | 7 | 3 | 0 | 0 |
| 4184 | 15 | 10 | 0 | 0 | 4 | 0 | 0 | 0 |
| 4190 | 5 | 0 | 0 | 0 | 9 | 6 | 0 | 0 |
| 4191 | 60 | 60 | 3 | 17 | 325 | 65 | 0 | 1 |
| 4194 | 25 | 15 | 0 | 0 | 137 | 35 | 0 | 0 |
| 4195 | 25 | 25 | 3 | 0 | 113 | 42 | 0 | 0 |
| 4196 | 45 | 40 | 0 | 0 | 108 | 13 | 0 | 0 |

Ten samples (11.5 percent) failed to meet the specifications for canning grade sugar. This is in comparison with 6.9 percent which failed to meet the specifications last year. Failure of the samples to meet the standards this year was again due to high total aerobic thermophilic and flat sour type bacteria. Four of the samples were from factories which had excessive numbers of thermophilic bacteria in the sugar during the previous year. It is significant to note that during the past two years none of the samples have contained excessive numbers of hydrogen sulfide or hard swell type of spores. This, of course, does not mean that all strikes of sugar produced during this time would have met the canners specifications for these types. It should also be pointed out that not all of the strikes of sugar making up the ten composites that failed to meet the specifications this year would contain excessive numbers of spores.

Fourteen samples contained more than 100 mesophilic bacteria per gram as compared with 10 samples last year. Yeast cells were recorded in only one sample and five samples produced five or more mold colonies per gram. Although, as previously indicated, there are no standards for molds, it is felt that five or more mold colonies per gram is an indication of undue exposure of the sugar to sources of infection in the sugar end of the factory, or to careless handling of the composite.

A review of the extent of contamination by thermophilic type organisms in 531 composite samples tested during the past seven campaigns was made to determine which type organisms was most frequently responsible for the failure of samples to meet canners specifications. The results, which are given in Table IV, show that 63 samples or 11.8 percent of the total contained an excessive number of thermophilic organisms. Further examination shows that only six samples contained an excessive number of sulfide spoilage and hard swell type spores. Of these six samples two contained an excessive number of flat sour type spores.

## TABLE IV

### Analysis of Samples by Years Showing Number Containing Excess Thermophilic Spores of Each Type

| | Samples Tested | Within Standard | | Samples Below Standard Because of | | | |
|---|---|---|---|---|---|---|---|
| | | | | T. C. * | F. S. ** | S. S. *** | T.A.**** |
| Year | No. | No. | Percent | No. | No. | No. | No. |
| 1941 | | | | | | | |
| 1941 | 87 | 77 | 88.5 | 6 | 10 | 0 | 0 |
| 1940 | 87 | 81 | 93.1 | 5 | 7 | 0 | 0 |
| 1939 | 75 | 65 | 86.7 | 7 | 9 | 0 | 3 |
| 1938 | 77 | 74 | 96.1 | 3 | 3 | 0 | 0 |
| 1937 | 70 | 65 | 92.9 | 2 | 4 | 2 | 1 |
| 1936 | 70 | 59 | 84.3 | 6 | 10 | 0 | 0 |
| 1935 | 65 | 47 | 72.3 | 12 | 17 | 0 | 0 |

* T. C. = Total plate count. ** F. S. = Flat sour.
*** S. S. = Sulfide spoilage. **** T.A. = Thermophilic anaerobes.

Fifty-nine samples or nearly 94 percent contained excessive numbers of flat sour and non-acid-forming spores, which is an indication of the importance to be placed on these organisms. While it is highly desirable to maintain a routine check on the occurrence of sulfide spoilage and hard swell type organisms, less emphasis should be placed on them than on the other types. The examination of a weekly or bi-weekly composite would probably be sufficient except in cases where contamination has been known to occur. A strict control should be maintained of other types, however, because of the extent to which they grow in the factory and also because of their significance in the food industry.